SIEMENS

Volume XXVI · May 2|91
pp. 51 to 90

# Siemens Components

## High Quality: Zero-defect Concept

## 12-V Line Protection with Varistors

## P1 SMD Miniature Relay

## SAW Filters for TV Receivers

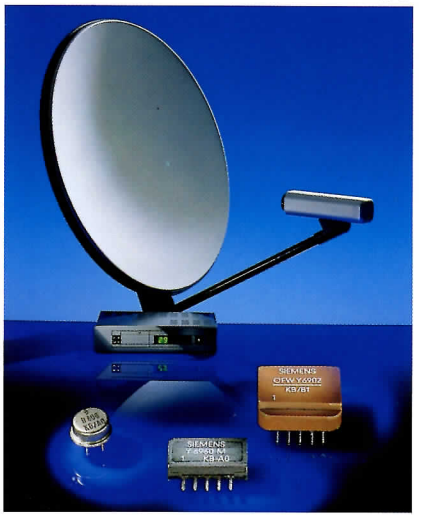
## New Video Pulse Generator

## IC for GSM Mobile Radio

## SMPS Works in Current-mode

# Siemens Components

2|91



**Cover Picture**

For direct reception of TV broadcasts via satellite, the transmitted 12-GHz band is converted into the IF band in low-noise microwave circuits. Siemens offers GaAs components worldwide for this purpose. The quality of the received pictures depends on how succesfully the 27-MHz transponder bandwidths of the satellites can be used. The advantage of SAW filters over LC filters in solving this problem is discussed on page 65.

**Imprint**

Published by:
Siemens Aktiengesellschaft, Berlin and München

Semiconductor Group, München
Managing board: J. Knorr, R. Braun, H. Fischer
Responsible for Siemens Components: G.-P. Elfe

Passive Components and Electron Tubes Group, München
Managing board: K. Ziegler
Responsible for Siemens Components: E. Schmid

Electromechanical Components Division, München
Headed by: M. Kasserra, H. Brauneis, R. H. Slavin
Responsible for Siemens Components: H. Wester

Responsible Publisher: J. Detig, München, Erlangen
Publishing manager: H. Koch. Editorial Board: J. Vogt (Editor-in-Chief), G. Felkel, G. Probst, München

© 1991 by Siemens Aktiengesellschaft, Berlin and München. All rights reserved.

Reprints of extracts are authorized in that the original source is credited and two copies are sent to the editors. Reprints of articles in full requires the permission from the editor. The photographic reproduction of individual articles for professional and other purposes is allowed. No responsibility is assumed for the consequences of the use of the given circuits, descriptions and tables nor for infringement of patents or other rights.

Siemens Components is published six copies a year. Suggested retail price: 7.30 DM per copy, annual subscription 43.80 DM (including VAT, postage extra). Available from bookstores and news agents.

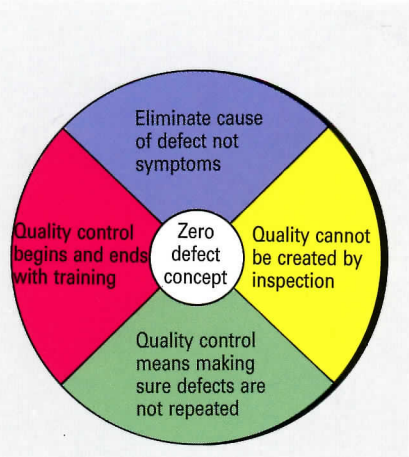
Inquiries should be addressed to:
Siemens Aktiengesellschaft, Siemens Components, Hellabrunner Straße 1, W-8000 München 90, Federal Republic of Germany, Fax (089) 2348434, Phone (089) 2348341, Ttx 89870304 = siemcw

Printed by Mayr Miesbach, Druckerei und Verlag GmbH, Am Windfeld 15, 8160 Miesbach
Printed in the Federal Republic of Germany

---

The aim of the zero-defect concept is to accept no defects in the products and services from any part of a company. It is not quality assurance by inspection but the enhanced reponsibility of all employees in relation to the statistical process control. These requirements have been met in the acoustic surface wave filter plant at Munich.

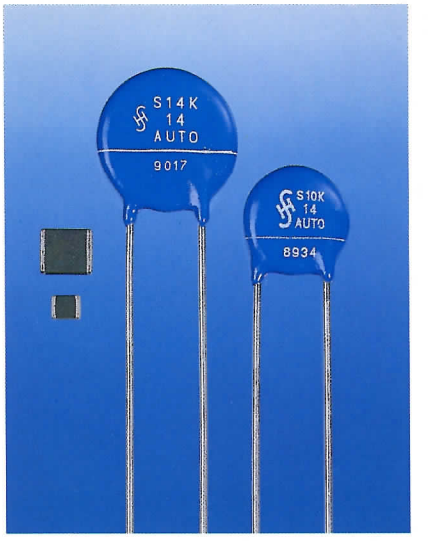
**page 52**


Eliminate cause of defect not symptoms
Quality control begins and ends with training
Zero defect concept
Quality cannot be created by inspection
Quality control means making sure defects are not repeated

---

Ensuring electromagnetic compatibility (EMC) for electronic components in automotive electrical systems calls for considerable engineering effort. For example, as laid down in the DIN 40389 standard, energies up to 100 joules must be absorbed at load dump. This and other tasks in RFI suppression are performed inexpensively by metal oxide varistors. The variety of types underlines their adaptability to many different applications.

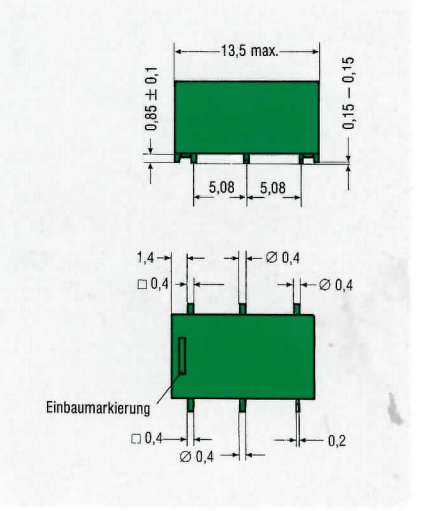
**page 58**



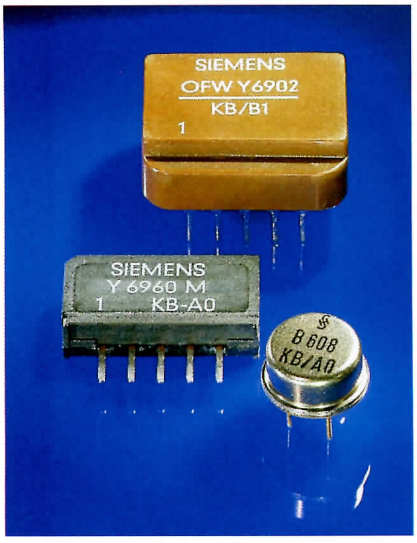

---

The use of special high-temperature-resistant plastics provides high sensitivity and dielectric strength in the P1 miniature relay, which is now also available in a further developed SMD version. The extremely low volume meets all requirements of conventional soldering methods on the pc board, as well as those of high-reliability applications such as vibration or shock stress.

**page 62**

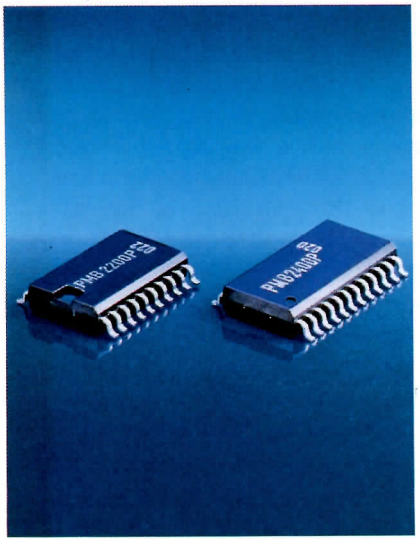


# CONTENTS



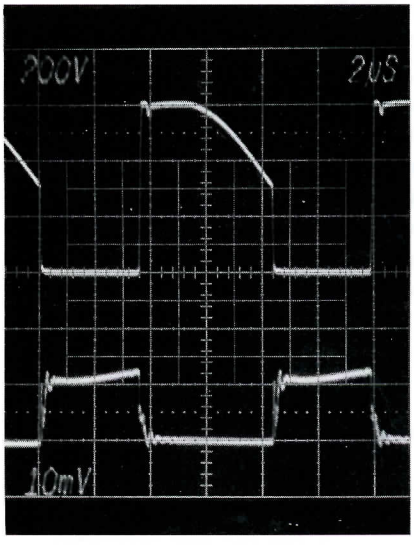

Surface acoustic wave filters have already been used for IF filtering in TV receivers for many years. Now they are starting to replace coil filters in satellite indoor units. This is because the particular features of SAW filters cannot be provided by LC filters – or only at considerable expense. Among these features are precisely defined bandwidths and a very steep rate of voltage rise in the passband.

**page 68**



For the development of mobile radio in the new GSM pan-European, digital mobile communication networks, the entire transmission link has to be digitized. All parts of the system require new electronic components optimized for the application. A chip set designed by Siemens for the GSM transmitter/receiver is already available.

**page 72**




This circuit proposal using the current-mode principle and the TDA 4919 integrated circuit is a 126-W switched-mode power supply of high efficiency and operating reliability. Besides directly driving the power transistor, the control circuit can monitor drain voltage, drain current and link voltage, for example. This SMPS could be used as a charger for battery-powered tools.

**page 77**

**TRENDS**

Werner Faber **52**
Higher Quality with the Zero-defect Concept

Erich Assmann **54**
Customers Buy Quality

**ENGINEERING**

Franz Fritze **55**
The Latest in SMD Standardization

Otto Schmid **58**
Protection for Automotive Electrical Systems with SIOV Metal Oxide Varistors

Ulrich Kobler **62**
Further Development of the P1 Miniature Relay

Arno-Alexander Filbig **65**
SAW Filters Compete with Coil Filters in Satellite TV Receivers

Robert Reiner, Kurt Biermann **68**
TBB 278 Video Pulse Generator Comparison with Predecessor S178A

Emil Badura **72**
New Integrated Circuits for GSM Mobile Radio

Applications:
Reinhard Blöckl **77**
Switched-mode Power Supply Using Current-mode with TDA 4919 Control IC

**COMPONENTS SERVICE**

NTC thermistor · axial tantalum electrolytics · ferrite N37 · RS 3011C generator triode · SAW filters · ceramic chip capacitors · LL transponder · FDDI relay · semiconductor lasers SFG 480301 to 487406 **83**

**IN FOCUS**

News from the components world **90**

**DOCUMENTATION**

Summaries of articles

**BRIEFLY EXPLAINED**

Ferrites, Part 8

Werner Faber

# Higher Quality with the Zero-defect Concept

**No faults or mistakes in the products and services of all divisions of a business: that is the aim of the zero-defect philosophy. But the path to this ideal is littered with obstacles. This article recounts the experience of the group for surface-acoustic-wave filters of Siemens Matsushita Components, Munich, when a zero-defect concept of this kind was introduced.**

Acceptable quality level or AQL is often the measure of product quality that is arranged with customers and suppliers. The AQL figure stipulates the maximum number of defects in statistical terms that may appear in a delivery. Such an arrangement obviously means that a business will tolerate a certain number of defects. The risk here, however, is that such an attitude will gradually be adopted by each employee and that the expected defects will therefore come about more or less as a self-fulfilling prophecy.
This way of thinking has to be changed, not only for the benefit of the customer but also for the manufacturer's own benefit. A useful guide to the right direction is the zero-defect concept.

## Recognizing weaknesses

If quality is genuinely to be improved and lastingly, then quality consciousness founded on the principles of the zero-defect concept can be an important requisite. To find the right approach for correcting quality consciousness in the production of SAW devices at Siemens Matsushita Components, the existing situation was first thoroughly analyzed. And it became clear that quality assurance could be improved in some respects.

## Inspection-oriented quality assurance

Quality assurance was based on inspection and testing. The employees' attitude to quality was directed at passing these tests, and the QA department saw itself as the only competent contact in matters of quality. It administered and retained all graphs and figures that said anything about quality. Reworking was regarded as an unavoidable part of the process and perfected accordingly.

## Inspection hinders productivity

When inspection shows that there are defects, they have to be remedied. In every case the result is extra costs for reworking the components or scrapping them. Productivity is hindered and without any marked improvement in the AQL that is characteristic of these systems.
In QA procedures based on inspection you often find that there are more and better trained employees engaged in all the checks and tests than in the task of process optimization. This capacity could be utilized to much greater advantage in a different QA concept.

## It takes rethinking

Improving the long-term quality level in such circumstances calls for a new attitude towards quality. A.V. Feigenbaum provides a good leitmotif in his description of quality: »Total Quality Management (TQM) is ensured by an organization that coordinates the efforts to improve quality of all parts of a business in such a way that there are constant improvements in products and services to the satisfaction of the customer«.
This goes far beyond defining quality simply as »delivering to specification« or »suitable for the purpose«. Definitions of this kind share the common drawback that they restrict themselves to inspection, i. e. to filtering out defective products.
TQM puts the responsibility for quality in the hands of each and every employee and includes services as well as the products. TQM calls on quality assurance to motivate, train and support employees in their efforts to improve quality. So, as an aid in creating new quality consciousness, TQM also provides the guidelines for adapting an internal organization to the new objectives. Only signals and changes that are visible externally will guarantee sustained improvement in the attitude towards quality.
A zero-defect concept cannot be introduced overnight however. One has to implement the ideas step by step.

## Responsibility for quality

If you transfer responsibility for quality to a special department, e.g. quality assurance, you run the risk that other departments will show less interest in

Dr. Werner Faber, Siemens AG,
Leiter der Fertigung OFW-Komponenten,
Siemens Matsushita Components GmbH & Co. KG,
München

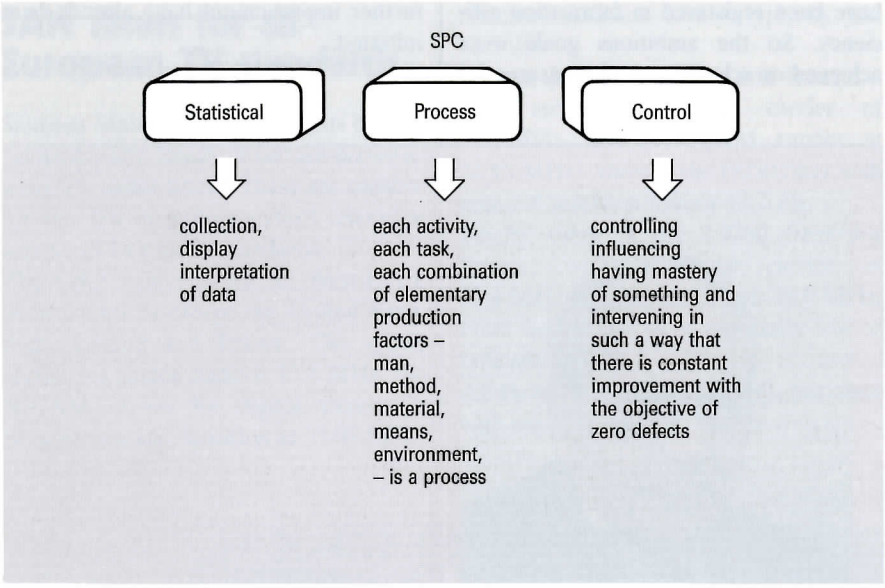

SPC
Statistical
Process
Control
collection, display interpretation of data
each activity, each task, each combination of elementary production factors – man, method, material, means, environment, – is a process
controlling influencing having mastery of something and intervening in such a way that there is constant improvement with the objective of zero defects

**Fig. 1 The aim of statistical process control (SPC) is to have full control of a process at all times**

quality. This is quite understandable: because even if quality is listed among the tasks that these departments are expected to handle, everyone knows that quality assurance still bears the ultimate responsibility. Consequently, in our SAW operations, the first step was to entrust development and production with responsibility for product quality. At the same time the competences and means were also matched to the new task.

The task of the QA department now consists in training and supporting the other departments in matters of quality and in coordinating all the individual activities across the top of the departments. Further key roles of QA are those of monitoring the quality of suppliers and representing the company vis-à-vis customers on questions of quality.

## Extended process understanding

Each activity is a process formed from a combination of the elementary production factors man, machine, material, method and environment. Process control means having mastery over a process at all times with the aim of achieving improvements again and again. With the extension of the term process the responsibility for quality is also extended beyond the manufacturing departments to those that provide services. So a perfectly typed letter by a secretary is just as representative of quality as a doorman who can give a first-time visitor the precise information he needs.

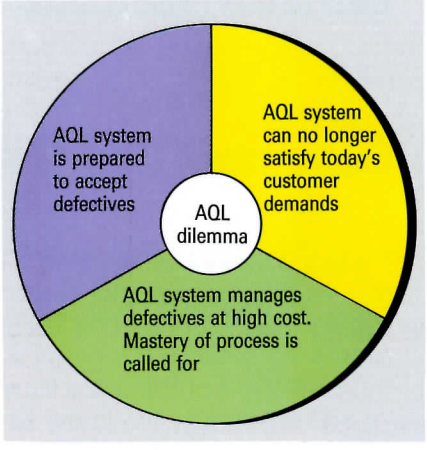

AQL system is prepared to accept defectives
AQL system can no longer satisfy today's customer demands
AQL dilemma
AQL system manages defectives at high cost. Mastery of process is called for

**Fig. 2 Quality assurance based on AQL has marked disadvantages**

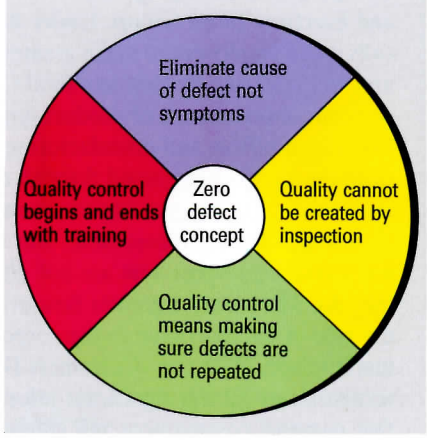

Eliminate cause of defect not symptoms
Quality control begins and ends with training
Zero defect concept
Quality cannot be created by inspection
Quality control means making sure defects are not repeated

**Fig. 3 The zero-defect philosophy produces substantial improvements in quality**

## Statistical process control instead of inspection-oriented quality assurance

This step means nothing other than applying the commandment: »The basic principle of quality assurance is prevention« (P.B. Crosby). Quality tests, inspection and checks follow on at the end. So defects are sorted out unreliably.

Wire bonding was selected as a pilot project for statistical process control (SPC) in SAW operations. This manufacturing step not only affects the quality of the end-product to a large degree, the process result also depends very much on the quality of the parts that are supplied, i.e. the lead frames. This means that the supplier also has to be brought into the zero-defect concept.

## Involving the supplier

More than 50% of the quality problems in production are directly or indirectly related to suppliers. Material that is not delivered punctually will disturb a process to the same degree as material with a large proportion of defects.

We were able to do away with incoming inspection for the most part. But this means that the supplier has to be prepared to monitor, control and document his processes so that he can guarantee delivering us fault-free material at the right time. Communicating this to the supplier, i.e. involving him in the zero-defect concept, is a task for the QA department.

## Keeping an eye on targets and successes

It is well enough known that factors like

- achieving an objective,
- recognition of one's efforts,
- satisfying work,
- responsibility and
- realization of progress

are positive motivation for every person and therefore have a substantial effect on the performance of a business. If an individual cannot see what the objective is, these factors will not help to enhance

performance. In our SAW operations the targets and results like yield and fabrication efficiency are displayed in readily comprehensible form at the busiest locations in the plant and are updated from day to day. Only the appropriate announcement of realistic goals can make a substantial contribution to achieving these goals.

### Recognition of employee effort

Recognition is a major facet of motivation. Material incentives are suitable here, such as a prize scheme that is directed to achieving quality and quantity targets and rewards the personal performance of an individual employee. But personal recognition is also due. This was proved in SAW production with the transfer of responsibility. Highly capable machine operators were given responsibility for organizing production at the detailed level for instance, and this turned out to be a sweeping success.

### Further steps

Further steps are necessary in pursuing a zero-defect philosophy and making it a complete success. Every area, every process, every stage of the work has a »supplier« and a »taker«. Recognizing this principle and acting on it are decisive for the success of the zero-defect concept. So the same guidelines apply within the business as outside it. This kind of attitude has to be created and the rules must be obeyed consistently.
The new self-conception of the QA department, i.e. the greater responsibility in maintaining relations with customers and suppliers, must be made visible by assigning the appropriate competence. One of the right steps in this direction is combining the tasks of disposition, quality and logistics, and this has already been implemented in our SAW operations.

### Pleasing results

The efforts of recent years have been well worth it. The rejection rate has been halved in the course of three years for example, and marked improvements have been registered in fabrication efficiency. So the ambitious goals were achieved on schedule. And measures for further improvement have already been initiated.

**Erich Assman,**
**coordinator of the group-wide TQM strategy,**
**Passive Components and Electron Tubes Group of Siemens AG**

## Customers Buy Quality

The idea that customers by quality when they purchase goods or services is not new. We are proud of the fact that the quality of our products has always stood high and that our customers have a strong appreciation of this. But, like many other things, quality is changing in its content. This is good enough reason for us to keep taking a fresh look at the subject and an effective way to improve on the high expectations you already have.

The customer makes demands not only of the product but also of other things like the service available. Our wider understanding of quality therefore has to encompass a whole range of activities and functions in our business. This is background to a campaign that was recently started in the Passive Components and Electron Tubes Group. Under the banner »Customers Buy Quality«, it calls on all employees to make greater and conscious efforts to improve quality, and will lead step by step to »Total Quality Management« (TQM). The constant improvement of product quality will continue to be a top priority in our design offices and manufacturing plants, of course. Here we are profiting from the experience gained through cooperation with our Japanese partners. As costly as the product improvements may be individual cases, they have the advantage of being measurable. But in general it is important to develop the interest of employees who are not directly involved in production in the work they do. This means a greater flow of information – about goals, achievements, the role of the individual in the corporation, the role of the corporation in the marketplace. With the »Customers Buy Quality« campaign we want to communicate all this significant information to our employees in such a way that personal commitment will continue to develop, to the benefit of our customers.

The system installed in production for recording rejection data is working effectively. The next phase will see superordinate statistical process control by means of this system. Supervisors are virtually entirely responsible for sequence organization. The quality and quantity objectives are accepted by all employees, so internal »frictional losses« have reduced to a highly satisfactory degree. The correct consequences have been deduced from the setbacks, all in the interest of never ending improvement.

**References**

[1] Ishikawa, K.: What is Total Quality Control? The Japanese Way. Prentice-Hall.
[2] Cullen, J.; Hollingum, J.: Implementing Total Quality. Springer.
[3] Owen, M.: SPC and Continuous Improvement. Springer.
[4] Gitlow, H. S.; Gitlow, S. J.: The Deming Guide to Quality and Competitive Position. Prentice-Hall.
[5] Crosby, P. B.: Qualität ist machbar. McGraw-Hill.

**Franz Fritze**

# The Latest in SMD Standardization

**The significance of surface mounting is also reflected in national and international standardization. Virtually all the major component designs presently available are already set down in pertinent standards. The European working group CECC/WG-SMD has now produced a guide in which – independently of components design – standard test procedures for surface-mounted devices are formulated and compiled. The subject of soldering plays a central role.**

After printed-circuit technology and through-hole insertion of components, surface mounting is the next milestone in interconnection techniques. To a much greater degree than in conventional wiring and component insertion on circuit boards, there are critical interrelations in surface mounting between the processing methods on the one hand and the components on the other. Individual optimization does not produce an optimal overall solution. So it is the task of standardization to define component characteristics and testing methods on a high level of compromise by means of which critical stresses during processing can be simulated.

Of the many extra and stringent requirements that result from surface mounting, here are some of the major ones:

- minimum volume for the given electrical characteristics,
- low height to avoid shadowing in wave soldering,
- high temperature resistance,
- temperature-shock stressing,
- surface properties of leads and solderability,
- mechanical stressing caused by mounting devices and warping of the base after mounting.

Experts, firms, associations, standards committees have all set down their knowledge and experience on the subject in numerous publications, the wealth of data often making it difficult to find the literature that relates to a specific problem.

The European working group CECC/WG-SMD has set itself the task of producing a guide with an introductory part on the processing methods, followed by a main section, derived from this introduction, that describes standard test methods. This guide will be published soon as »CECC 00802: Standard Test Procedures for Creating Specifications for Surface-Mounted Devices with Quality Conformance«. The subjects of soldering heat and solderability receive special attention when it comes to practical problems.

## Resistance to soldering heat

The commonest methods of soldering at present are wave soldering, infrared soldering and vapor-phase soldering. **Figs. 1, 2** and **3** (taken from the abovementioned guide) show the characteristic temperature-with-time profiles of the different methods. The dashed limit curves are especially important because the component tests specified later on are centered on them. The characteristic

Dipl.-Ing. Franz Fritze,
Siemens Matsushita Components GmbH & Co. KG,
Technische Verbände und Normen,
Heidenheim

parameters of the individual soldering methods that are of special interest when it comes to the stresses exerted on components are as follows:

Vapor-phase soldering:
- uniformity of soldering heat (215 °C) without any appreciable spread,
- average rate of rise in temperature until soldering heat is reached,
- dwell time at solder temperature of up to 40 s.

Wave soldering:
- variation of the most usual solder temperatures 235 to 265 °C,
- shock-like increase in temperature until soldering heat is reached,
- dwell time at solder temperature maximally 10 s.

Infrared soldering:
- the increase in temperature and the temperatures reached in the given time depend on a variety of parameters like absorption coefficient of the surfaces, mass of the individual SMDs, size of the board, arrangement of components on the board, radiation characteristics.

Special significance attaches to the standard for translating the process parameters into suitable tests that will ensure special-to-process stresses: the component user must have confidence and the assurance that the process-oriented tests provide adequate coverage of the process that he employs.

A standard test that consisted of pairing the severest conditions for solder temperature (265 °C in wave soldering) with those for dwell time (40 s in vapor-phase soldering) would be ideal in terms of simplicity and clarity. But there would be too few components left available.

CECC/WG-SMD saw the optimum compromise in formulating equivalent test conditions tailored to the individual methods that will ensure resistance of a component to the stresses of the different soldering techniques. Infrared soldering presents difficulties. Because of the many variables that can influence the temperature/time profile of a component, it is not possible to have a strict assignment of test to soldering method. Here it has to be left to the user to find out whether his individual conditions are covered by one or other of the tests.

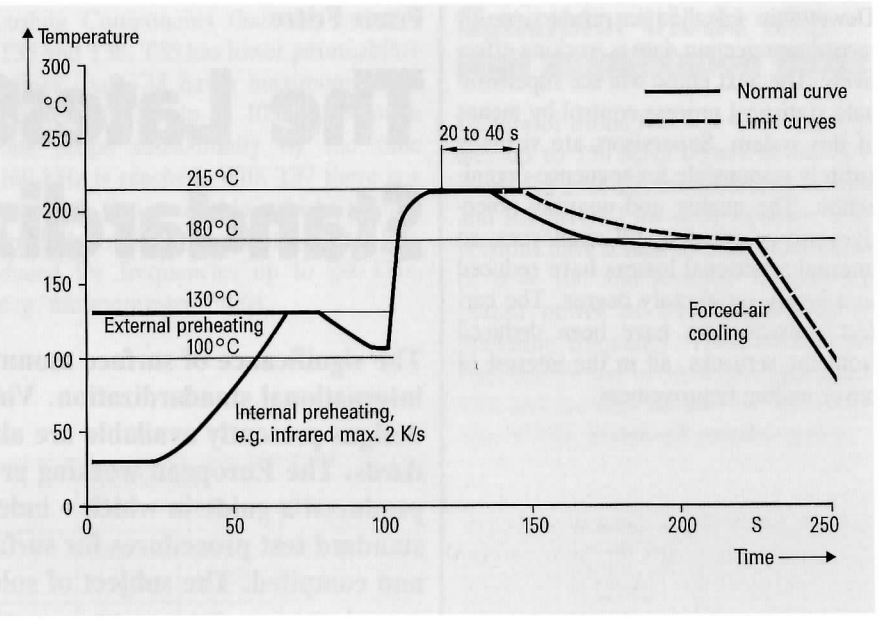



**Fig. 1 Temperature/time curve of vapor-phase soldering as pass-through operation with preheating; temperature on component lead is relevant**

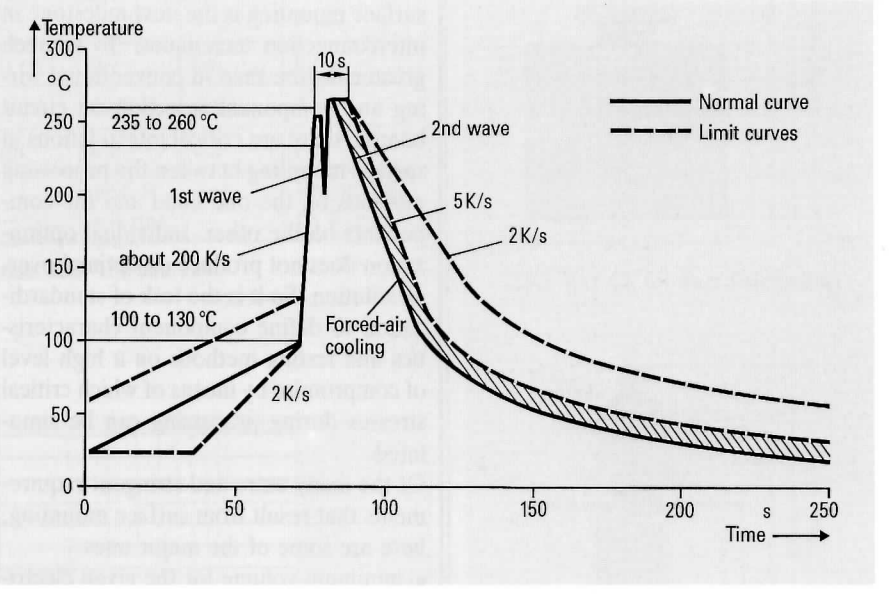



**Fig. 2 Temperature response on component lead in double wave soldering**

**Table 1** (extracted from CECC 00802) shows the individual test conditions and the associated soldering methods.

The code letters introduced for classification indicate whether a component has all-round suitability – as with class A – because it satisfies the test conditions 260 °C/10 s and 215 °C/40 s, or is restricted (single wave) as in class C1.

## Solderability

Soldering defects of the order of up to 3000 ppm indicate the special importance of component leads, although the ppm figure does not necessarily have to be solely attributable to them. Where components are concerned, their leads can influence the quality of a soldered joint as regards
- wettability,
- dewettability,
- decomposition strength.

Wettability is the characteristic by which solder takes to a defined, solderable surface at given values of solder temperature and dwell time in a solder bath.

Dewettability is the undesirable characteristic by which no new solder takes to a defined, solderable surface at specified values of solder temperature and dwell time in a solder bath. Possible cause: bronze phases on thinly tinned copper leads.

Decomposition strength is a characteristic of leads where no diffusion processes occur at defined solder temperature and for a given dwell time in a solder bath and so no surface material diffuses into the new solder.

The problem of decomposition only occurs where there is a lot of solder, as in wave soldering for example. Generally you can say that the more precious the material, the greater is the rate of diffusion. This is the reason why gold, for instance, is unsuitable for general-purpose use, and especially for wave soldering. The harmful results of diffusion are found in the embrittlement of the soldered joints, which can lead to breaks during temperature cycles combined with rigid leads and different coefficients of thermal expansion of components and boards. In other words, flexible leads are not affected by the problem.

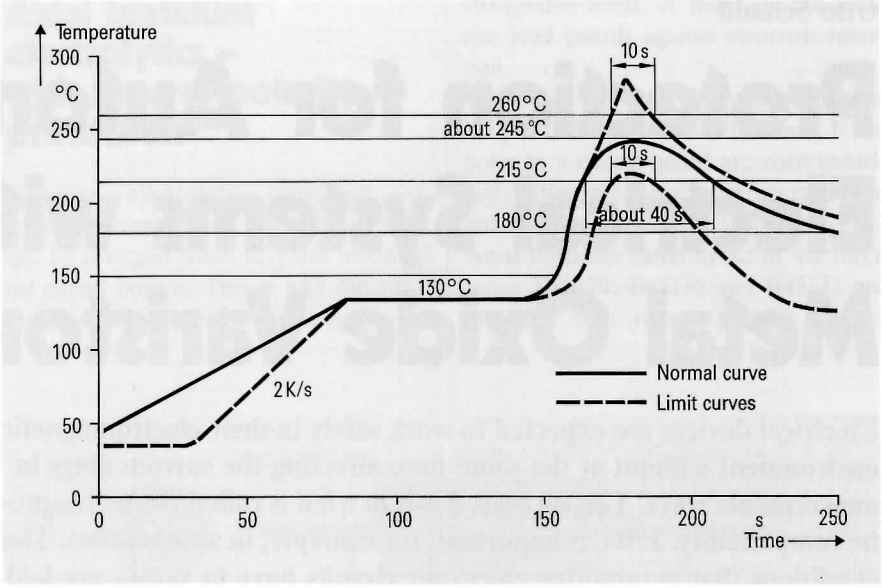



**Fig. 3 Temperature response on component lead in infrared soldering**

| Tested characteristic | Dip conditions °C | s | Associated soldering method |
|---|---|---|---|
| Wettability | 235 ± 5 | 2 ± 0.2 | Wave |
| | 215 ± 3 | 3 ± 0.3 | Infrared, |
| Dewettability | 260 ± 5 | 10 ± 1 | vapor-phase, wave |
| Decomposition strength | 260 ± 5 | 30 ± 1* | Wave** |

* The particular specification may prescribe reduced severity for decomposition strength by stating a duration of 10 or 20 s.
** See A.8.3 (b)

**Table 2 Dip conditions for solderability (wettability and dewettability) and decomposition strength**

| Class | Test conditions | Soldering method |
|---|---|---|
| A | 260 °C/10 s and** 215 °C/40 s | Vapor-phase, infrared*, double wave |
| A1 | 260 °C/5 s and** 215 °C/40 s | Vapor-phase, infrared*, single wave |
| B | 215 °C/40 s | Vapor-phase, infrared* |
| C | 260 °C/10 s | Double wave, infrared* |
| C1 | 260 °C/5 s | Single wave |

* Infrared soldering is included provided that the temperature stress during soldering does not exceed the thermal compatibility of the component, which is only ensured up to the conditions tested here
** Not immediately after one another in tests on the same items

**Table 1 SMD classification for soldering methods and tests**

On the question of soldering, the WG-SMD working group in the CECC has taken the appropriate test conditions from IEC 68-2-58 and compared them to the soldering methods that are to be simulated. **Table 2** (extracted from CECC 00802) shows the test conditions for the related soldering process.

It is important to remember – because in practice it is not usually done – that the surfaces and edges relevant to soldering should be stated in specifications. The first issue of the CECC guide is just a beginning. It contains the major tests. The less important ones had to be left out for lack of time and will be added in later issues. During its preparation, and the work of harmonizing between countries, it was pleasing to see that the guide stimulated a lot of discussion and constructive criticism. The interest shown in the USA and in Japan has led to proposals to use the CECC guide as a basis for consultation in IEC committees that are still to be established. So eventually we can expect to see a uniform version for IEC standardization worldwide.

Unfortunately standards are all too often the work of individuals. For which reason an appeal goes out to those experts who are interested – but have not yet been involved – to contribute their experience and raise the matters they regard as necessary so that this standard can properly mature.

**Reference**

Mather, J. C.: Component Attachment Reliability. Surface Mount Technology, CARTS USA, 1985

Otto Schmid

# Protection for Automotive Electrical Systems with SIOV Metal Oxide Varistors

**Electrical devices are expected to work safely in their electromagnetic environment without at the same time affecting the surroundings in unacceptable ways. This all boils down to what is called electromagnetic compatibility. EMC is important, for example, in automobiles. The conditions that automotive electronic circuits have to satisfy are laid down in DIN 40839, and this article explains how these electronic systems can be protected with metal oxide varistors.**

The use of more and more increasingly sensitive electronic components means that the task of fulfilling EMC requirements is becoming more complicated all the time. This is especially so when you consider that interfering energy of the order of mJ is sufficient to cause disturbances that can affect safety or even result in destruction.

Metal oxide varistors (**Fig. 1**) have been used in many applications as reliable protective elements with a very attractive price/performance ratio. A varistor (*var*iable res*istor*) is a voltage-dependent resistor whose resistance decreases with increasing voltage.

Metal oxide varistors have a ceramic body that consists of about 95% zinc oxide. The remaining 5% is composed of other metal oxide additives which adjust the electrical characteristics of the ceramic. Metal oxide varistors like the SIOV (*Si*emens metal *o*xide *V*aristor) are now in preferred use all over the world because of the optimal transient suppression they provide.

## How a varistor protects

Varistors are connected in parallel with the circuit that is to be protected (**Fig. 2**). They become low in resistance when voltage increases, so they absorb interfering energy and in this way prevent overvoltages from developing. For undisturbed operation in an application you need as high a resistance as possible so that the leakage current will be negligible. In the event of transients, however, the resistance must go as small as possible.

**Fig. 3** illustrates, in the case of the SIOV-S20K14AUTO, the high voltage dependence of varistors from Siemens Matsushita Components (S+M): the tolerance band for this type shows more than 500 kΩ for 14 Vdc but at 50 Vdc the figure is less than 1 Ω. **Fig. 4** then shows the associated tolerance band for the protection level (*U/I* curves).

## Toughest demands

DIN 40839 part 1 describes »interferences conducted along supply lines in 12-V on-board system«. The toughest

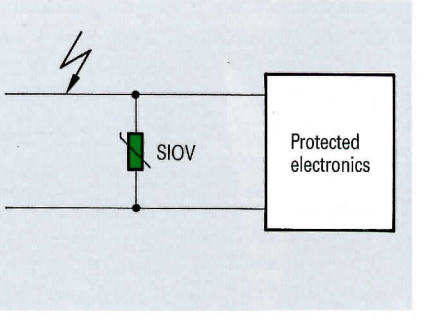



**Fig. 2 Protective principle with varistor in parallel with the load**

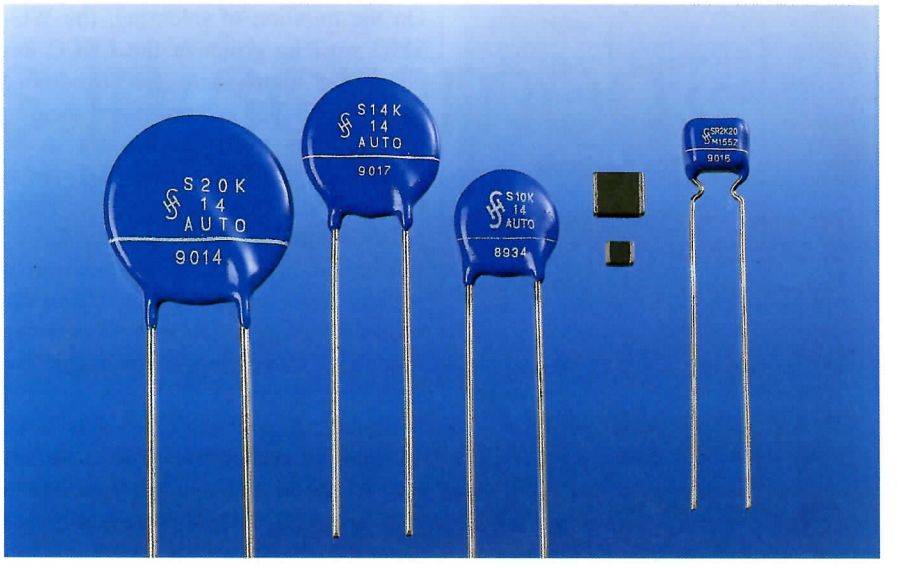



**Fig. 1 SIOV varistors, developed specifically for protection of automotive electronic systems**

Dipl.-Ing. Otto Schmid,
Siemens Matsushita Components GmbH & Co KG,
Produktmarketing Keramische Bauelemente,
München

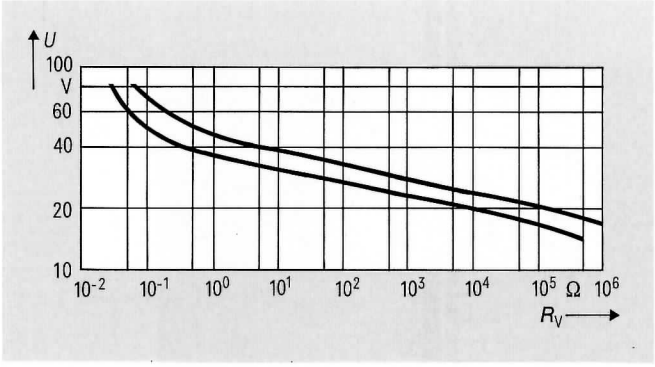



Fig. 3 Tolerance band for impedance of SIOV-S20K14AUTO, which is highly dependent on voltage

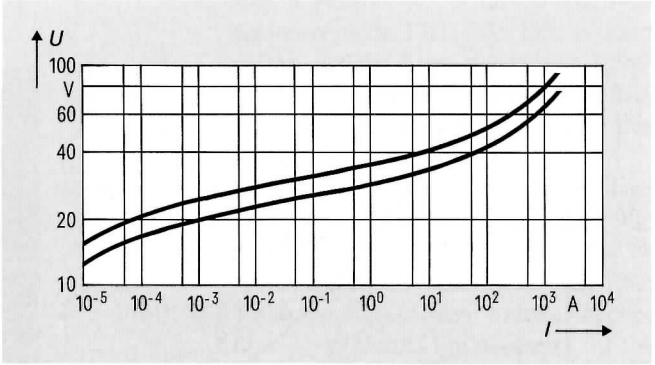



Fig. 4 Tolerance band of protection level correlated with the impedance in Fig. 3

demand for overvoltage protection is test pulse 5, which simulates generator load dump. Interference of this kind can be produced when the battery is disconnected from the generator at high charging rates, e. g. because a cable breaks. For several hundred milliseconds after this there can be voltages of as high as 200 V, and with energies up to 100 J.
This worst case can be dealt with by SIOV-AUTO varistors of the S20 series. They also handle the less energetic test pulses 1 through 4. **Figs. 5** and **6** show the electrical performance when there is a load dump of the order of 100 J.

## Special varistors for automotive electrical systems

SIOV-AUTO varistors are designed specially for the harsh conditions involved in protecting automotive electrical systems and are optimized for

- high energy absorption (at load dump),
- effective transient suppression, i.e. low clamping voltages,
- low leakage current,
- jump-start strength, i.e. the protective element should not be damaged if double the battery voltage is applied,
- immunity to polarity reversal (because of the symmetrical characteristic automatically given with varistors),
- wide operating temperature range,
- resistance to cyclic temperature stress.

The **table** gives the ratings for a selection of varistors.

## Local protection

Electronic components are often quite a distance apart, so EMC cannot be implemented with just one centralized protective module. Instead it is necessary to provide extra local protection, directly on the individual components. Here energy-absorption capability of a few joules to several tens of joules is adequate, so the protective components can be chosen for a lesser load and thus be smaller.

## Smallest dimensions: SMDs

The size can be reduced further by moving from leaded to surface-mounted varistors. Multilayer technology is very suitable, as here the active zones of the varistor are inside the ceramic (**Fig. 7**). In this way a protective coating can be dispensed with and very small sizes are feasible.
Moreover, the multilayer structure permits the use of especially fine-grain ceramic material with which, compared to monolithic varistors, the protection level can be reduced further (**Fig. 8**). For reasons of production engineering, multilayer technology is restricted to a max-

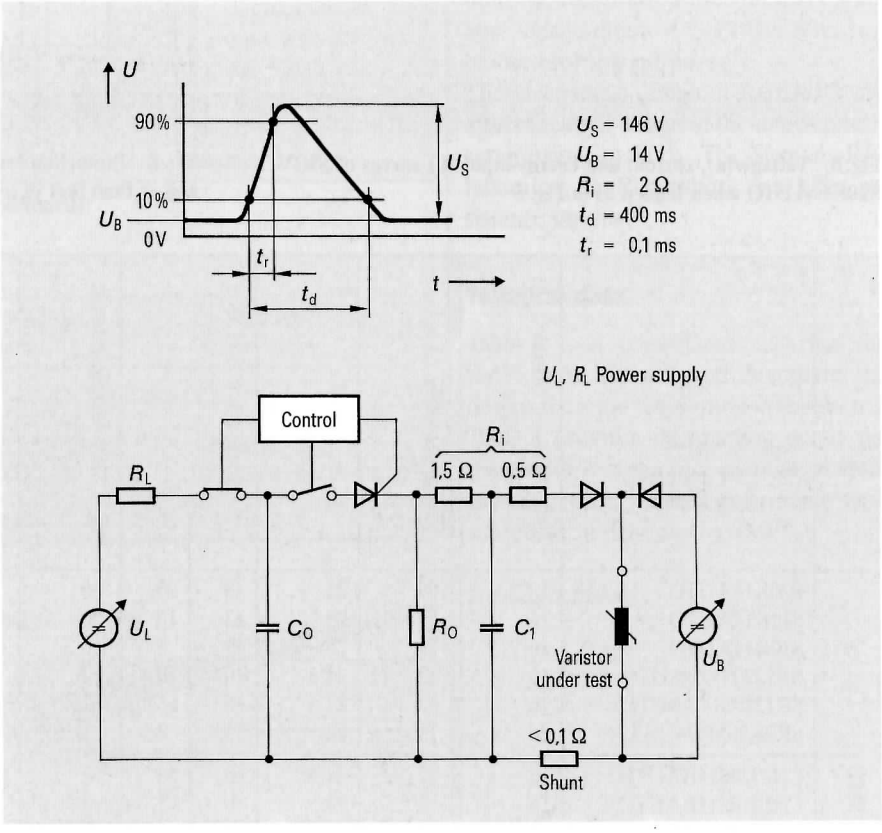



Fig. 5 100-J load dump to DIN 40839 part 1 and how it is generated with an LD generator

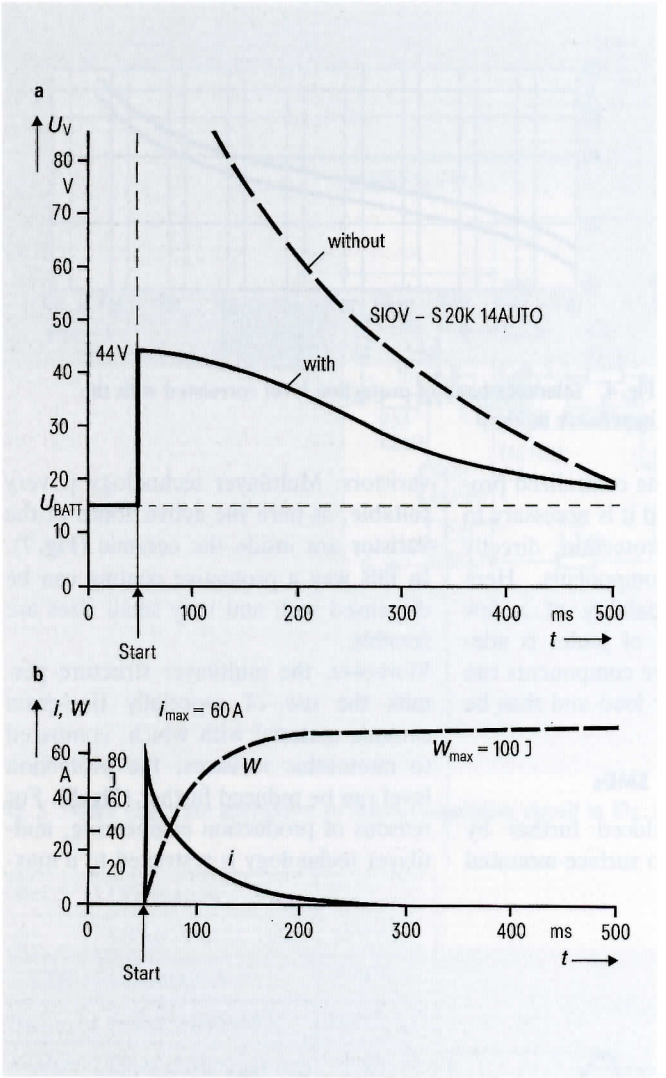



Fig. 6 Voltage (a), current and energy-input (b) curves of SIOV-S20K14AUTO when loaded as in Fig. 5

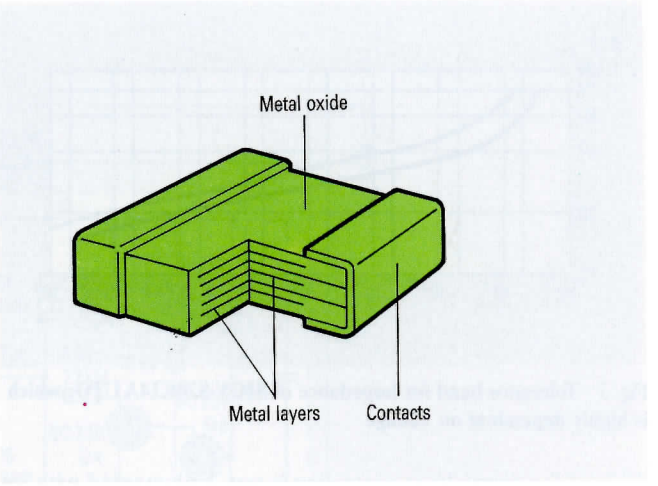



Fig. 7 Structure of multilayer SMD varistors, permitting omission of protective coating

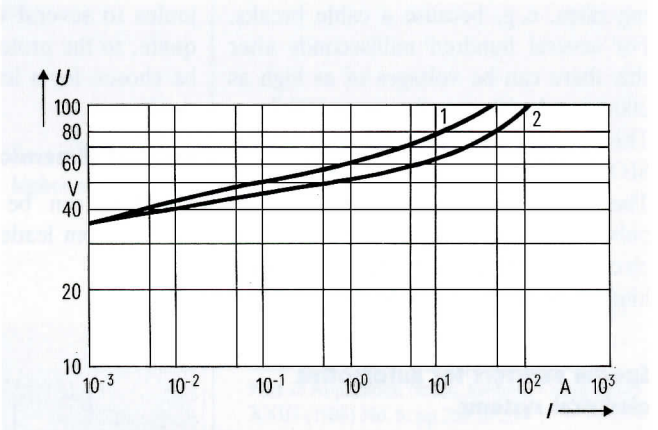



Fig. 8 Protection level of monolithic varistors (1) is substantially higher than that of multilayer models (2)

| | Type (for 12-V systems) | Max. permissible dc voltage | Load dump 10× | Jump start 5 min | Max. protection level at | | Max. leakage current at 14 V | Capacitance, typical (1 kHz) | Max. sizes S…AUTO | Max. sizes SR, CN |
|---|---|---|---|---|---|---|---|---|---|---|
| | | V | J | V | V | A | µA | nF | ∅ × H mm | L × W × H mm |
| Leaded | S20K14AUTO | 16 | 100 | 25 | 43 | 20 | 30 | 15 | 25 × 5.6 | |
| | S14K14AUTO | 16 | 50 | 25 | 43 | 10 | 20 | 9 | 19 × 5.3 | |
| | S10K14AUTO | 16 | 25 | 25 | 43 | 5 | 10 | 5 | 13.5 × 5.2 | |
| | SR2220S14BAUTO | 16 | 12 | 24.5 | 40 | 10 | 2 | 10 | | 9 × 7.5 × 3.8 |
| | SR1210S14BAUTO | 16 | 2 | 24.5 | 40 | 5 | 2 | 2 | | 6.5 × 5.0 × 3.1 |
| | SR2K20M474…155 | 26 | 15 | 26 | 55 | 2.5 | <1 | 470 to 1500 | | 9 × 7.8 × 5.5 |
| SMD | CN2220S14BAUTO | 16 | 12 | 24.5 | 40 | 10 | 2 | 10 | | 5.9 × 5.0 × 1.3 |
| | CN1210S14BAUTO | 16 | 2 | 24.5 | 40 | 5 | 2 | 2 | | 3.4 × 2.7 × 1.3 |

Table Selection of disk-type and SMD varistors from the S+M range for 12-V automotive electrical systems

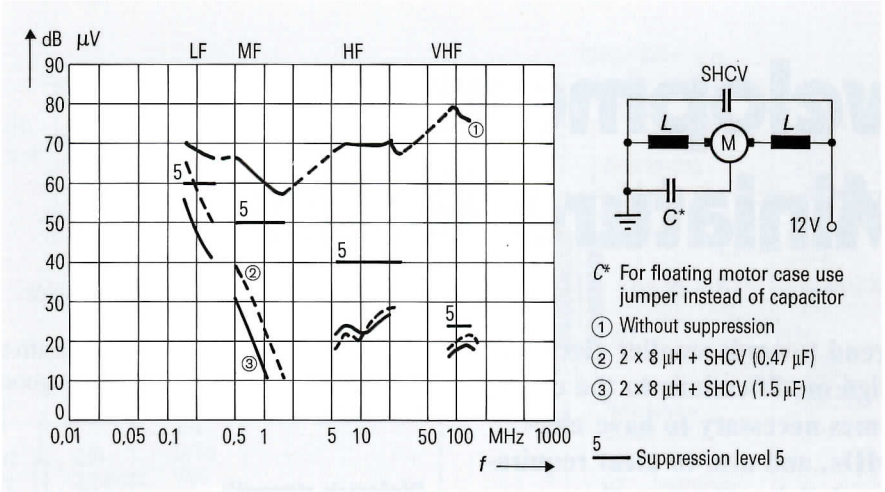



**Fig. 9 Example of RFI suppression of low-power motor when idling using chokes and SHCV (measured to VDE 0879 part 3)**

imum size of 5.7 mm × 4.8 mm (CN2220 type series) and operating voltages up to 30 V. S+M benefits here from its many years of experience in producing multilayer ceramic capacitors.

## RFI suppression with high-capacitance varistors

The inherent capacitance of varistors alone (a few nF) is not enough for RFI suppression. For this reason S+M has devised high-capacitance varistors called SHCVs (*S*+M *Hi*-*C*ap *V*aristors) with values up to 1.5 µF. In these components there is a multilayer capacitor of X7R or Z5U ceramic connected in parallel with a multilayer varistor of the CN2220 series. This makes overvoltage protection and RFI suppression available for the first time in an extremely compact design with just two soldered joints (**Fig. 9**).

## Numerous applications

The SHCVs from S+M are especially suitable for suppressing low-power motors of the kind used in automobiles, e. g. for windscreen wipers, power windows, memory seats and central locking. SIOV metal oxide varistors cover wide areas of overvoltage protection requirements as regards protection levels available, surge current handling capability and energy absorption. Their attractive price/performance ratio has thus made them indispensable for a wide range of applications in electrical and electronic engineering. **Fig. 10** shows some typical examples from the S+M range of products.

## References

SIOV Metal Oxide Varistors. Shortform Catalog 1990/91, Siemens Matsushita Components GmbH & Co KG, ordering code B5-P6202-X-X-7400

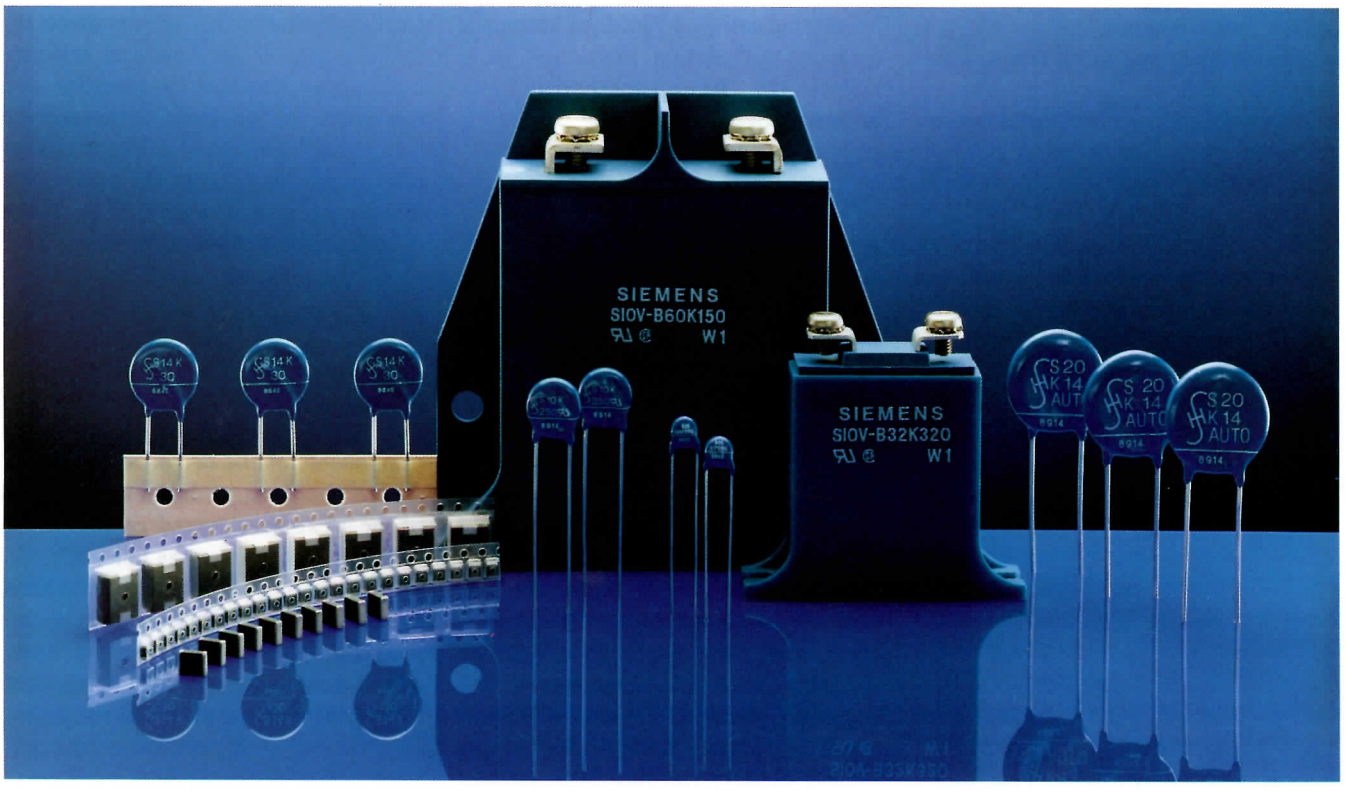



**Fig. 10 Varistors from S+M protect electronic units and installations, from computers to power engineering**

Ulrich Kobler

# Further Development of the P1 Miniature Relay

**New technologies and the general trend towards smaller electronic equipment necessitate continual design modifications to the components on the pc board. Thus it becomes necessary to have electromechanical relays available as SMDs, and also to meet requirements for high sensitivity and increased dielectric strength.**

On the basis of the standard P1 miniature relay with pin connections, it has been possible to develop an SMD version for all conventional soldering methods, thanks to the use of high-temperature-resistant plastics. Thus, despite the extremely small size, the MR P1 meets all the requirements of a modern miniature relay such as:

- SMD version,
- high sensitivity,
- increased dielectric strength,

and other features such as:

- short function times,
- high vibration and shock resistance,
- long life and
- approvals and environmental protection.

## SMD version (Fig. 1)

The further development of the standard relay and its variants with pin connections to produce the SMD version has been made possible by consistent use of specially selected high-temperature-resistant plastics. The dimensions have been increased slightly as compared with the standard version ($L \times W \times H_{max}$ = 13.5 mm × 7.9 mm × 8 mm = 0.85 $cm^3$). This SMD version is suitable for all conventional soldering methods, and the maximum soldering temperatures and times specified below are permitted:

| | |
|---|---|
| Vapor phase: | 215 °C, 40 s |
| Infrared: | 215 °C, 40 s |
| Double wave: | 260 °C, 10 s |

The MR P1 is packaged in a stick magazine containing 40 relays, suitable for automatic machine handling, and can be inserted easily on boards by automatic component insertion machines (e. g. Siemens HS 180) with appropriate travel or bench lowering cycle.

## Sensitivity

While the low power consumption and high response sensitivity of the monostable version permit energization of the standard-version MR P1 by a standard TTL device without additional drivers, it has been possible to follow the trend towards the more recent TTL devices e. g. ALS, with the highly sensitive version of the MR P1. With a power consumption of only 35 mW, the MR P1 can be driven easily by the 8 mA output of the TTL-ALS **(Fig. 2).** Moreover, the new version has advantages such as the much lower heat generation, so that no special measures are required even with swichting matrices, i. e. maximum packing density. And even the power supply for the circuitry can now have a lower rating. In battery-powered equipment in particular, the use of this highly sensitive monostable version is particularly good for battery life.

## Dielectric strength

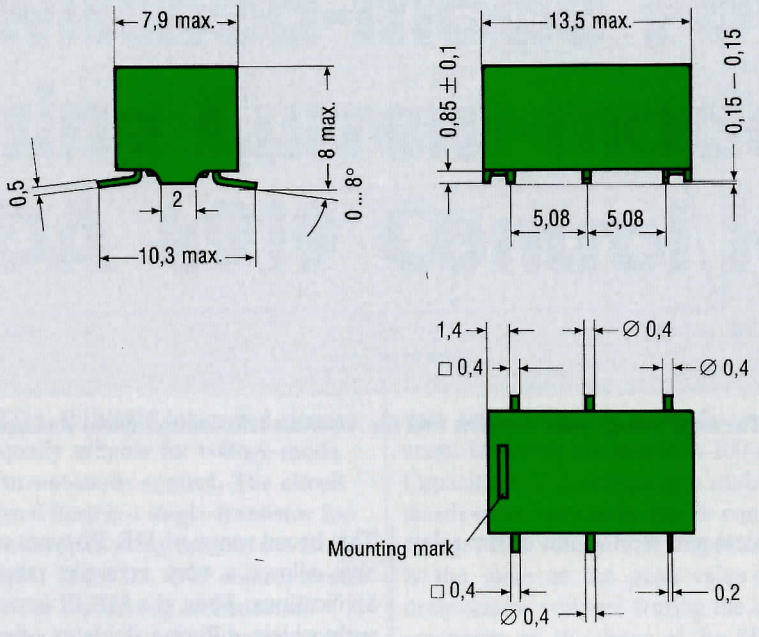
A high dielectric strength is ensured on the one hand by the physical construction, the usefully designed pin spacing with a grid of 2 × 2.54 mm and, on the other hand, by the encapsulation of the relay in a special epoxy resin. In the standard version, the dielectric strength of the winding-contact gap is 1.5 kV (rms) and the figure is 0.5 kV (rms) from contact to contact. As an option, a version is available with a dielectric strength of 2 kV (rms) for the winding-contact gap (input-output), in particular for meeting the requirements of railway signaling and telecommunications engineering. One further version meets the requirements of an American telecommunications standard. It complies with the surge voltage pulse in accordance with FCC[1] 68.302, 1.5 kV, 10/160 µs **(Fig. 3).** In this version, the power consumption is approximately 50 % greater than that of the standard version.

## Function times

The very short function times result from the extremely miniaturized design and the mechanical characteristics of the components of the magnetic circuit and contact circuit, in particular the low mass of the wear-freemounted center spring. The function times are as follows:
approximately 1 ms for the operate time,
approximately 0.35 ms for the release time and
approximately 1 ms for the bounce time.

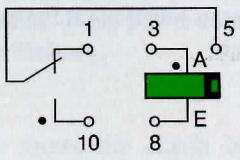
Dipl.-Ing. (FH) Ulrich Kobler, Siemens AG, Geschäftsgebiet Elektromechanische Komponenten, Vertrieb Relais, München

[1] FCC = Federal Communications Commission



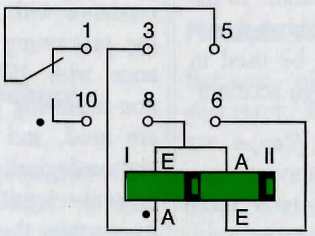

Base connections

V23026-D1... monostable and
V23026-F1... bistable (1 winding)

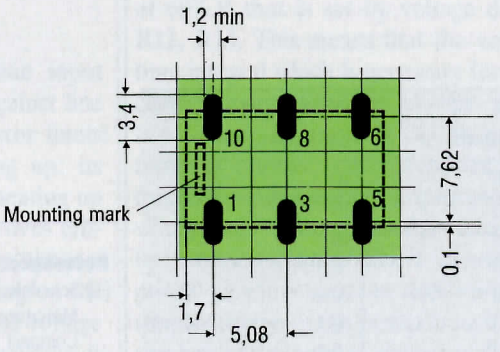



Circuit symbols drawn in »off« state. If a positive potential is applied to terminal 3, the relay assumes the »on« state

V23026-E1... bistable (2 windings)




Circuit symbols drawn in »off« state. If a positive potential is applied to terminal 3 or a negative potential is applied to terminal 6 with respect to terminal 8, the relay assumes the »on« state




View from component side of the pc board

**Fig. 1 Dimensions and base connections of the P1 miniature relay as an SMD**

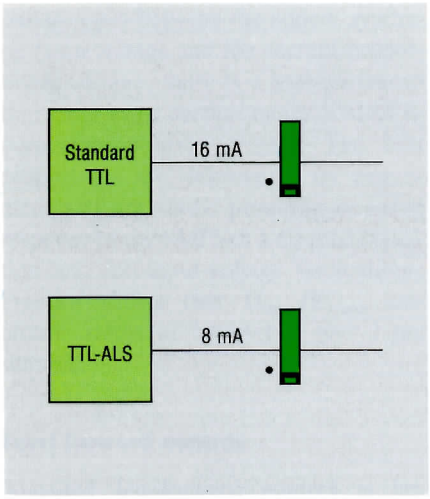



Fig. 2 Control with TTL component

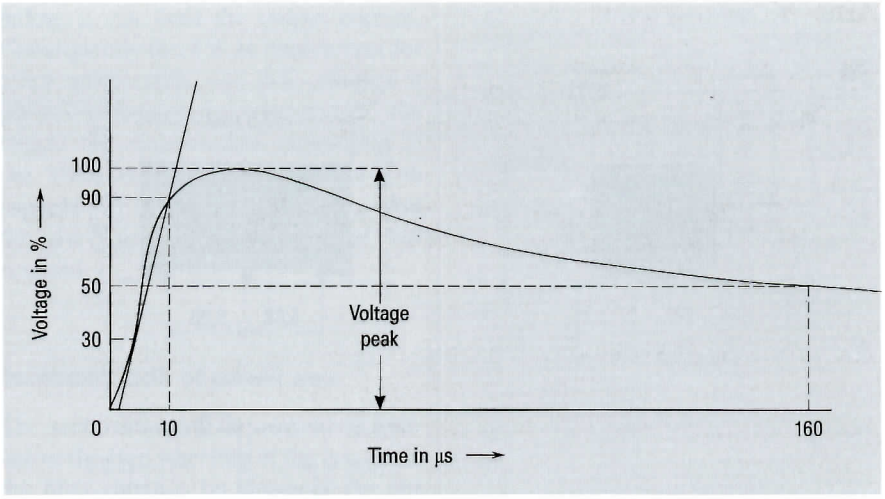



Fig. 3 The surge voltage pulse complies with the American telecommunications standard

### Vibration and shock resistance

Thanks to the low mass of the center spring, it is also possible, among other things, to achieve the high vibration resistance of 400 m/s$^2$ at frequencies up to 2000 Hz. The shock resistance when subject to a semi-sinusoidal shock of 11 ms is over 1000 m/s$^2$ without the contacts opening for longer than 10 µs. Thanks to this vibration and shock resistance, the MR P1 can even be used in equipment subject to very high acceleration forces.

### Life

The gold-plated, rhodium-plated, bifurcated contact comprises a multilayer sandwich design and is suitable for the entire load range. This, in addition to the washable encapsulation and getter of the contact chamber, contributes to the long mechanical and electric life of the relay **(Table).**

### Approvals and environmental protection

It goes without saying that the MR P1 is UL and CSA-listed, flameproof in accordance with DIN IEC 695 and meets the processing requirements in accordance with IEC 68. Specially selected non-degassing plastics and epoxy resins are used, and these are toxicologically and ecologically harmless on the basis of present scientific findings. The washability permits the relays to be cleaned in inert fluorine and in the aqueous solutions used to an increasing extent to reduce environmental pollution. The relay can also be washed using ultrasonic methods thanks to the sandwich construction of the contact.

This broad range of MR P1 types available allows a very versatile range of applications. Thus, the MR P1 is used in such widely differing fields as telecommunications, medical engineering, mobile radio, automotive engineering, precision mechanisms and security systems, mechanical engineering and data systems, in addition to measurement systems. In all these fields of application, the MR P1, with its inherently high reliability, performs functions at the end of the logic circuit.

| Switching voltage V | Switching current mA | Life Operations | Determined at Operations/s |
|---|---|---|---|
| 0 DC | Dry circuit | $10^9$ | 10 |
| 6 DC | 100 | $5 \cdot 10^7$ | 10 |
| 24 DC | 50 | $2 \cdot 10^7$ | 10 |
| 24 DC | 1000 | $3 \cdot 10^6$ | 0.1 |
| 100 DC | 500 | $5 \cdot 10^5$ | 0.1 |
| 125 AC | 400 | $2.5 \cdot 10^5$ | 0.1 |
| 220 AC | 400 | $2 \cdot 10^4$ | 0.1 |
| Contact material PdNi gold-plated, rhodium-plated | | | |

Table 1 Life specifications of P1 miniature relay

**References**

[1] Schedele, H.; Schweiger, J.; Tamm, H.: The Miniature Relay P1, a Highly Sensitive Ultra-Compact Relay. Siemens Components XXI (1986) No. 4, pp. 137 to 142

[2] Siepmann, R.: IC Control of Modern Miniature Relays. Siemens Components XVII (1982) No. 1, pp. 4 to 7

Arno-Alexander Filbig

# SAW Filters Compete with Coil Filters in Satellite TV Receivers

**The advantages of coil filters have been well known for decades. But surface acoustic wave filters are now gaining recognition as a high-grade alternative particularly in new applications such as satellite receiver systems.**

Surface acoustic wave filters, which have already been used for years in TV sets for IF filtering (**Fig. 1**), are now also coming into satellite indoor units to replace conventional coil filters. One reason why SAW filters are preferred is their advantage of bandwidths which can be preset accurately and which do not have to be set or readjusted by the user. Other problems which are solved by SAW filters for the development engineer are discussed below.

## Receiving satellite programs with satellite TV outdoor and indoor units

The frequency-modulated radio/TV signals broadcast by the Kopernikus satellite are received by the outdoor unit of a TV satellite receiving system using a dish antenna. At the focus of this antenna is a SHF (super high frequency) converter; or a LNC (low noise converter) which converts the signal received (10.95 GHz to 11.75 GHz and 12.5 GHz to 12.75 GHz) to the first IF. When downconverted to a carrier frequency of between 0.95 GHz and 1.75 GHz it is fed to the satellite indoor unit which amplifies the signal by up to 35 dB and converts it by a mixer to the second IF of 479.5 MHz. In the following stage, IF filtering, the IF filter has the task of filtering out the selected channel with optimal bandwidth and group delay and of keeping adjacent channels and noise away from the demodulator IC. With a frequency-modulated signal whose spectrum is theoretically infinite it is possible to limit the bandwidth only because the singal amplitude is decreased at a certain frequency. However, because the external spectral lines are suppressed, there is nonlinear distortion, the effect of which can no longer be avoided.

If one wishes to minimize distortion, though, the channel provided by the satellite transponder must be utilized to the full. Now that wideband frequency modulation is in general use for satellite transmission, the required bandwidth can be calculated by the following formula using frequency deviation ($\Delta F$) and baseband width $B_{NF}$:

$$B_{B(FM)} = 2 \times (\Delta F + B_{NF})$$

(modulation index >1).

For a baseband width of approx. 6 MHz and a deviation of 13.5 MHz this means a value of 39 MHz for the bandwidth of wideband frequency modulation. As **Table 1** indicates, this value, which is desirable for good image quality, can only be achieved through the transponders of the DFS Kopernikus 1 satellite.

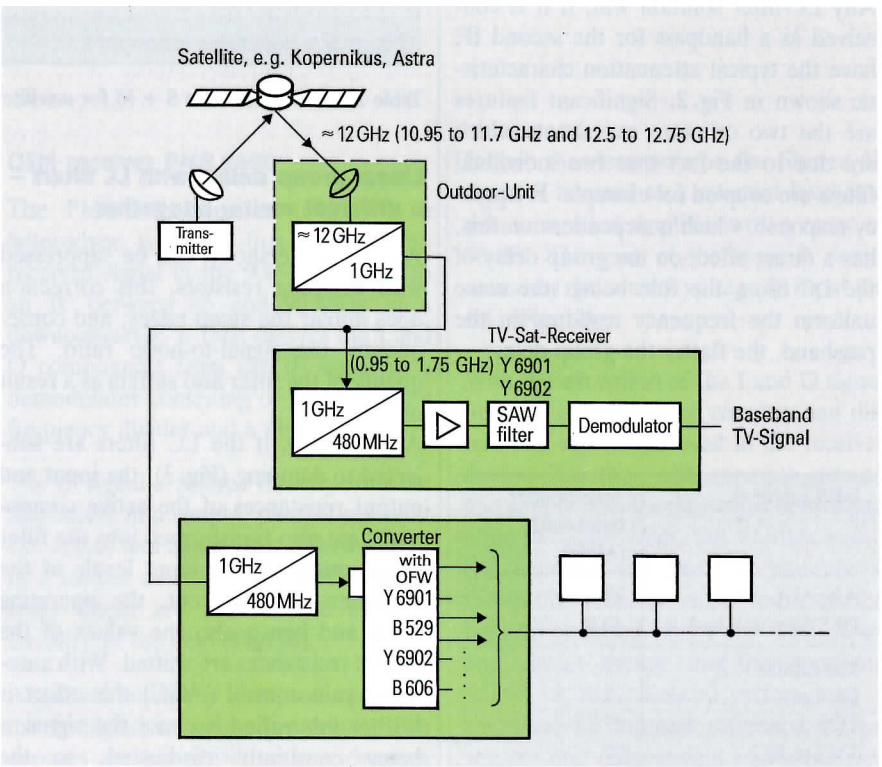



**Fig. 1 Block diagram of the satellite TV receiver. Surface acoustic wave filters, which have already been in use for years for IF filtering in television sets, and are now being applied in satellite indoor units instead of conventional coil filters**

Dipl.-Ing. Arno-Alexander Filbig,
Siemens Matsushita Components GmbH & Co. KG,
Produktmarketing Oberflächenwellenfilter,
München

In most cases the signal is already limited to 27 MHz at the transmitter. The need to utilize the various channels of a satellite transponder to the full bandwidth thus becomes evident.
Another factor is that with some satellites the television standards D2MAC and DMAC, which have much greater baseband widths than the normal PAL signals, are already being broadcast. Consequently, the problem of nonlinear distortion is even more serious for DMAC/D2MAC than for PAL because of the limitation to 27 MHz.

### Limited bandwidth means steepedge bandpass filters

To ensure that the information content of picture and sound signals can be received with as high fidelity as possible, despite the bandwidth limitation to 27 MHz the rising edges of the bandpass filter characteristic must be as steep as possible. This means single-section LC filters can generally be ruled out. If, however, multi-circuit LC filters are used, time-consuming tuning work on group delay, center frequency and passband ripple is inevitable.
Any LC-filter solution will, if it is conceived as a bandpass for the second IF, have the typical attenuation characteristic shown in **Fig. 2.** Significant features are the two or more overshoots which are due to the fact that two individual filters are coupled for example. Frequency response, which is dependent on this, has a direct effect on the group delay of the LC filter, the rule being: the more uniform the frequency response in the passband, the flatter the group delay.

| DBS satellites | Transponder bandwidth (MHz) |
|---|---|
| Astra 1A, 1B | 27 |
| DFS Kopernikus 1 | 40.9 |
| Marcopolo 1, 2 | 27 |
| Olympus 1 | 27 |
| TDF 1 | 27 |
| TV Sat 1, 2 | 27 |

**Table 1 Transponder bandwidths of the most widely used direct broadcasting satellites (DBS) in Europe**

| SAW filters for DBS (direct broadcast satellite) applications | | | | |
|---|---|---|---|---|
| Filter | Package | IF in MHz | 3-dB bandwidth in MHz | Remarks |
| Y6901 | DIP10 | 479.5 | 27 | |
| Y6902 | DIP10 | 479.5 | 24 | |
| Y6401 | DIP10 | 479.5 | 27+24 | |
| Y... | DIP10 or TO-39 3-Pin | 479.5 | 20 | under development |
| Y... | DIP10 or TO-39 3-Pin | 479.5 | 16 | under development |
| B611 | TO-39 4-Pin | 479.5 | 18 + 27 | under development |
| B612 | TO-39 4-Pin | 479.5 | 27 + 24 | under development |
| B607 | TO-39 4-Pin | 479.5 | 27 + 32 | |
| B608 | TO-39 3-Pin | 479.5 | 27 | |
| B610 | TO-39 3-Pin | 479.5 | 24 | |
| B605 | TO-39 4-Pin | 402.78 | 27 | |
| B609 | TO-39 4-Pin | 402.78 | 27 + 31 | |
| SAW filters for DSR (digital satellite radio) applications | | | | |
| X6960 M | SIP 5 K | 40.15 | 10.0 | |
| X 6950 | SIP 5 L | 70.0 | 10.9 | |
| Y 6960 M | SIP 5 K | 118.0 | 10.0 | |
| SAW filters for CS (communications satellite) applications | | | | |
| Filter | Package | IF in MHz | 3-dB bandwidth in MHz | Remarks |
| X... | | 70 | bei 1 dB 5.0<br>bei 30 dB 8.9 | under development |
| Filters with switchable bandwidths | | | | |

**Table 2 SAW filter from S + M for satellite applications**

### Linear group delays with LC filters – a different matter altogether

Although overshoots can be suppressed with damping resistors, this correction does impair the steep edges, and consequently the signal-to-noise ratio. The quality of the filter also suffers as a result of damping.
Alternatively, if the LC filters are subjected to damping (**Fig. 3**), the input and output resistances of the active components are also transformed into the filter arrangement. If the input levels of the amplifiers are different, the operating point and hence also the values of the output resistances are shifted. With automatic gain control (AGC) this effect is further intensified because the signal is being constantly readjusted, so the operating point and output resistance are constantly changing. If coupled LC filters are to achieve good results, the primary and secondary damping resistors must always be of the same magnitude; this is a requirement which is impossible to meet in the case of damping. However, since the input and output resistances tend to drift apart, this causes one of the coupled circuits to be damped more than the others (**Fig. 4**).

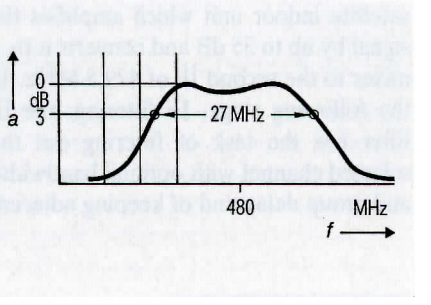



**Fig. 2 Typical attenuation characteristics of coupled LC filters. Significant features are two or more overshoots**

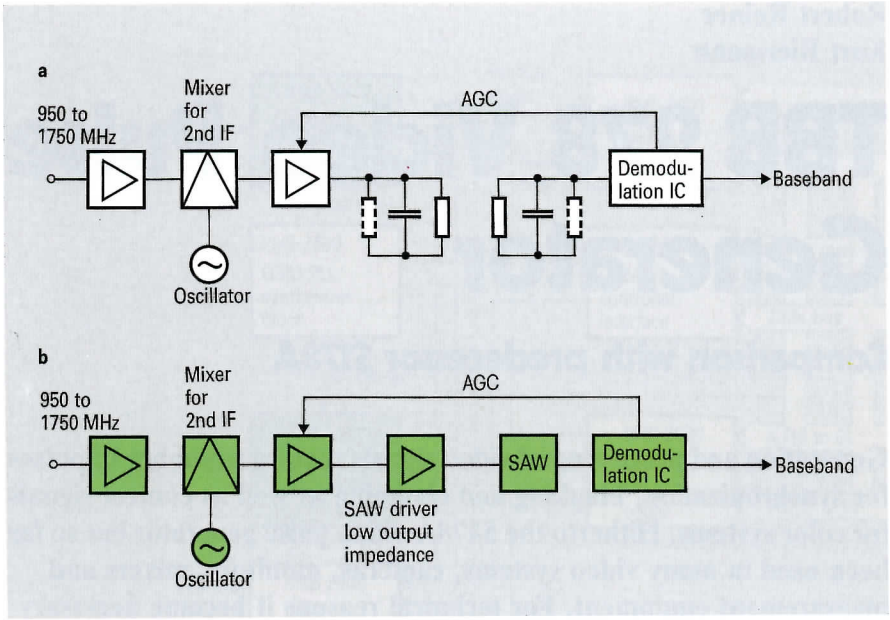



**Fig. 3 Block diagram of a satellite TV indoor unit using LC or SAW filters**
**a if LC filters are used for damping, the input and output resistances of the active components are also transformed into the filter arrangement so that the filter characteristic is changed**
**b if SAW drivers and SAW filters are used, the change of the input and output resistances of active components (AGC) has no influence on the filter characteristic**

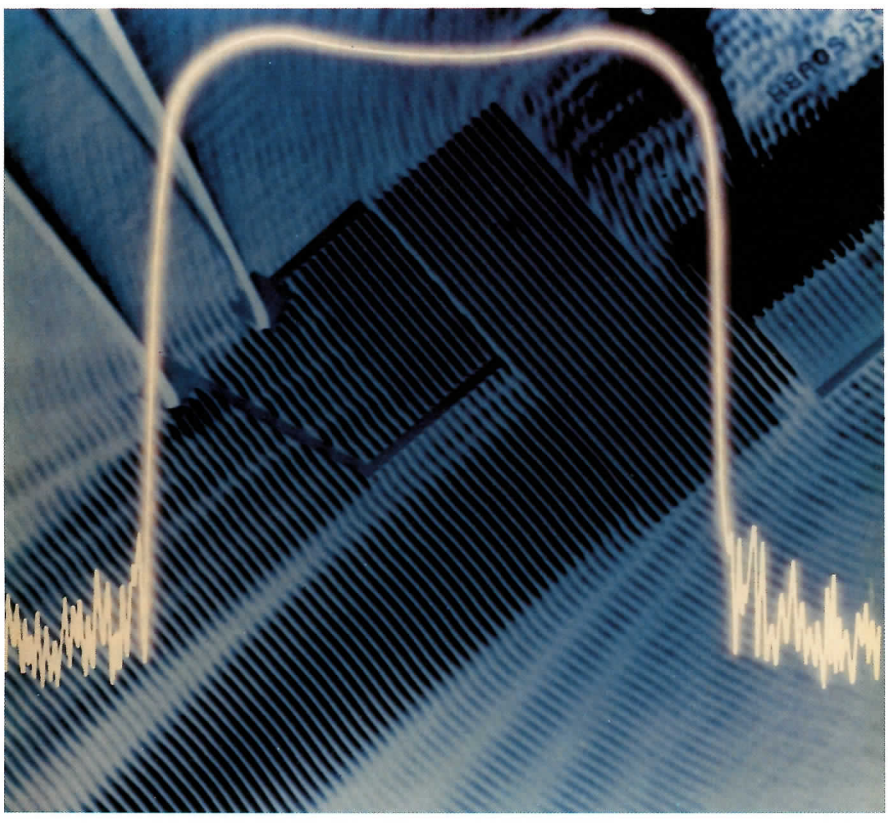


**Fig. 5 Depending on the shape and arrangement of the combs the signal behavior of SAW filters can be varied to match frequency and time requirements. This also applies to the center frequency of the satellite SAW filters which, for example, can be tuned to a center frequency of 480 MHz with comb finger spacing of approx. 1 µm**

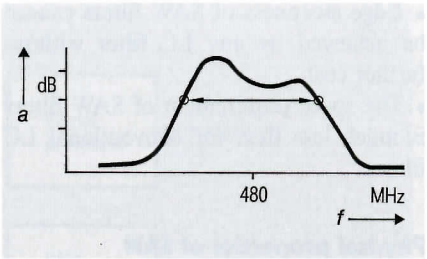



**Fig. 4 With damping by coupled LC filters, it is unavoidable that one of the coupled circuits is damped more than the other. This leads to a more marked overshoot profile**

The next consideration is at what levels the LC filter should be adjusted. If one decides to use low levels, higher levels will be distorted by the different input and output resistances of the active components. Distortion also occurs if conditions are reversed.

Anyone who wishes to achieve low group delay ripple despite these problems must equalize the filter characteristic. The effort would lead to a substantial increase in cost and is therefore seldom done in practice. When one considers picture quality, differences are evident between a module with flat group delays and one with fluctuating values, that is, both in fine textures and in large areas of color.

Faced with the effort involved in achieving optimal picture quality with LC filters, many development engineers are already looking out for alternative filters for satellite receivers which have a fixed center frequency, steep limiting edges and linear group delays.

## SAW satellite filters win hands down

Anyone who wishes to consider SAW filters instead of LC filters will soon be convinced by the advantages of surface acoustic wave components after seeing the first designs:

- SAW filters in satellite indoor units have the advantage of precisely defined bandwidths which do not have to be trimmed or adjusted.
- Their group delay can be specially tuned to the requirements of the demodulation IC.
- Their input or output impedance can be designed as required by the chip set.

- Edge steepness of SAW filters cannot be achieved by any LC filter without further cost.
- The space requirement of SAW filters is much less than for conventional LC filters.

### Physical properties of SAW components

SAW filters utilize the piezoelectric effect. Changing the applied potential generates a mechanical wave on the chip. In turn, mechanical pressure causes changes of potential. Lithium niobate is used as the chip material. The fingers of the comb-like electrodes are interlaced with spacings in the micron range. A RF voltage fed to the input transducers launches a mechanical (acoustic) surface wave on the crystal. The wave propagates to the output transducer and is reconverted back into a voltage. Bandwidths are determined by the electrode mechanical design – such as the size, number and spacing of the fingers. This also applies to the center frequency of satellite SAW filters which, for example, are tuned to a center frequency of 480 MHz with comb finger spacing of approx. 1 µm. As in semiconductor technology, such small structures make special demands on photolithography. The process quality with our SAW filters is the same as with current 1-Mbit memories.

**Robert Reiner**
**Kurt Biermann**

# TBB 278 Video Pulse Generator

## Comparison with predecessor S178A

**Generation and processing of video signals require a number of pulses for synchronization, blanking and clamping as well as control signals for color systems. Hitherto the S178A video pulse generator has so far been used in many video systems, cameras, monitors, mixers and measurement equipment. For technical reasons it became necessary to develop a follow-up product. This gave an opportunity for improvements and extension of functions. The new TBB 278 is now available. The article explains how it differs from the previous type.**

The TBB 278 is function-compatible with the S178A so that it can replace the S178A in all systems. It also offers important additional functions. It is not, however, pin-compatible with the S178A. Two packages are available: plastic DIP-22 and PLCC-28. The new IC is manufactured in CMOS technology. This simplifies power supply (only +5 V) and the power consumption is drastically reduced.

### Programming

The pin configuration is shown in the **Table**. It was possible with the S178A to set six different systems using the three inputs NA, NB and NC. Independently of these, any number of lines could be stipulated using ten further inputs. The TBB 278 uses fewer connections and has even greater flexibility. This has been achieved by providing a serial programming facility in addition to the parallel input programming capability. The selection of these two modes is via input EPS. At the same time, the meaning of some connections is changed; those used as inputs with parallel programming become inputs and outputs for color systems with serial programming.

#### Parallel programming

High level is applied to input EPS. It is possible to select 16 specified standard systems using the four inputs NA to ND. The number of lines is permanently assigned for each system ( table 1, parallel programming table, in [1], page 893). Using input PR/**LI**, it is possible to stipulate independently whether or not interlacing is to be used (level high = interlacing on). The mode of synchronisation is selected using input PS/**SW** and the built-in oscillator is switched on or off (see **Fig. 1**). New programming is only effective immediately at input PS/**SW**: the states of inputs NA to ND and PR/**LI** become effective only at the start of the following full frame, i.e. with the (falling) leading edge of the FR output.

Dipl.-Ing. Robert Reiner,
Siemens AG, Bereich Halbleiter,
Produktdefinition Autoelektronik/Industrieelektronik, München

Dipl.-Ing. Kurt Biermann,
Siemens AG, Bereich Halbleiter,
Produktdefinition Autoelektronik/Industrieelektronik, München

| | S 178A DIP 28 | | TBB 278 DIP 22 | | | PLCC 28 |
|---|---|---|---|---|---|---|
| | 1 | $U_{SS}$ supply voltage +5 V or 0 V | 1 | $V_{DD}$ supply voltage +5 V | | 1 |
| | 15 | $U_{DD}$ supply voltage −5 V or −10 V | 3 | $V_{SS}$ supply voltage 0 V | | 4 |
| Programming | – | | 11 | **EPS** = »L«: serial progr. | **EPS** = »H«: parallel progr. | 15 |
| | 25 | NA inputs for | 12 | **CL**/NA inputs for | CL/ **NA** inputs for | 16 |
| | 24 | NB parallel programming | 13 | **D**/NB serial progr. | D/**NB** parallel | 17 |
| | 23 | NC ,, | 14 | see outputs | PI/**NC** program- | 19 |
| | – | | 15 | see outputs | BC/**ND** ming | 20 |
| | 2 | 2^9/10 10 inputs for | – | | | – |
| | : | : line number programming | : | | | : |
| | : | : ,, | : | | | : |
| | 11 | 2^0 ,, | – | | | – |
| | – | | 9 | see synchronization | PR/**LI** interlacing (»H« = on) | 12 |
| | – | | 8 | see outputs | PS/**SW** input sync mode selection | 11 |
| Synchronization | 17 | clock input $f_{clock} = 64 \cdot f_{line}$ | 19 | OSCO oscillator output/input for external clock | | 25 |
| | – | – | 18 | OSCI oscillator input | | 24 |
| | – | – | 16 | PD output for PLL low pass filter | | 21 |
| | 13 | S(V) input for vertical synchronization pulse | – | | | – |
| | 18 | S(H) input for horizontal synchronization pulse | – | | | – |
| | 12 | VRin input for full frame reset pulse | – | | | – |
| | – | | 17 | SY sync signal input (FR or S) | | 23 |
| | – | | (9) | **PR**/LI PAL reset | **PR**/LI f. S9, S10, also see above | (12) |
| Outputs | 20 | Himp horizontal pulse | 4 | Himp | | 6 |
| | 27 | Vimp vertical pulse | 22 | Vimp | | 28 |
| | 28 | A blanking signal | 7 | B | | 10 |
| | 21 | S synchronization signal | 2 | S | | 3 |
| | 16 | H/2 half periode of line | 21 | H/2 | | 27 |
| | 26 | A(H) horizontal blanking pulse | 6 | B(H) | | 8 |
| | 22 | Kt clamping pulse | 10 | Ct | | 13 |
| | 14 | VR full frame reset pulse | 5 | FR | | 7 |
| | 19 | VA vidicon blanking signal | 20 | RA/**8V** 8V signal | **RA**/8V resistron blanking signal | 26 |
| | – | | (14) | **PI**/NC PAL/SECAM ident. | see programming | (19) |
| | – | | (15) | **BC**/ND window color burst | see programming | (20) |
| | – | | (8) | **PS**/SW PAL square wave | see programming | (11) |

**Table Comparison of pin arrangement S 178A and TBB 278**

### Serial programming

(Fig. 3, pulse diagram for serial programming [1], page 895)
Low level is applied to input EPS. The PAL 625 system is preset when the system is switched on. An alternative system must be loaded via inputs **CL**/NA and **D**/NB (clock and data). A short high pulse (shorter than 2 µs) on line EPS serves as a strobe and transfers the information to a buffer register. The new programming only becomes effective at the start of the following full frame.
The following can be prescribed by serial programming:

- type of synchronisation
- pulse widths
- color system
- total line number per field (half frame)
- interlacing
- the number of front and back equalizing pulses and thus the width of the vertical sync pulses (table 3, coding with serial input specification in [1], pp 896 and 897).

In serial programming, connections **PI**/NC, **BC**/ND and **PS**/SW are used as outputs for the color system pulses: connection **PR**/LI is used as the sync input »PAL reset».

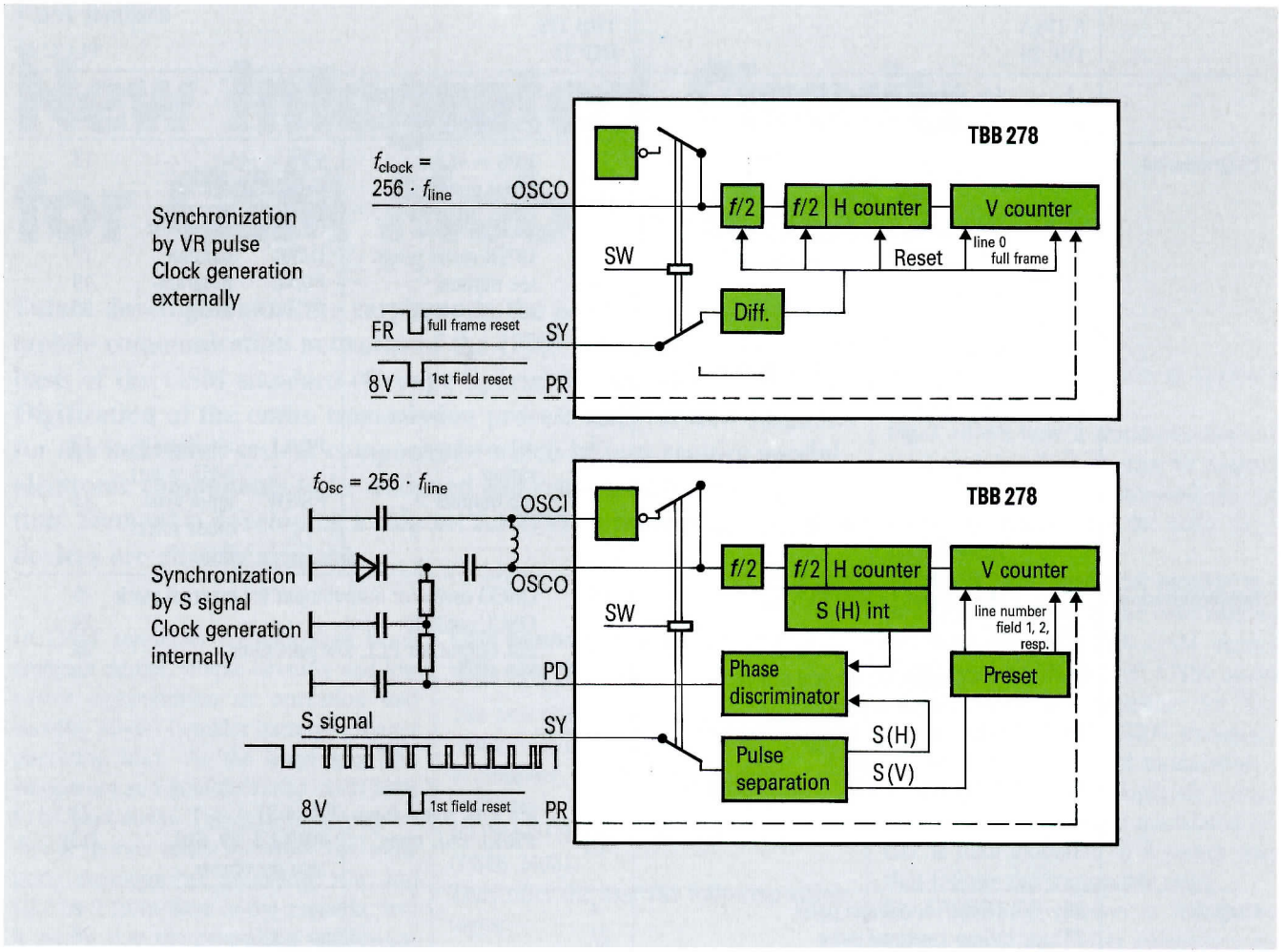



**Fig. 1 Synchronization with the TBB 278 video pulse generator**

### Synchronisation and clock generation (Table)

The provision of externally-generated clock pulses and external pulse separation for the sync was always necessary with the S178A (**Fig. 2**). With the TBB 278 (**Fig. 1**), it is possible to choose between provision of an external clock pulse and simple sync using an external FR pulse (frame reset), or operating with the built-in VCO and sync via an external S signal. With parallel programming, changeover occurs via input PS/**SW**: with serial programming via the SW bit.
The clock frequency with the S178A was 64 times the line frequency: with the TBB 278 it is 256 times the line frequency, so an external frequency divider stage is no longer required for balancing the pulse duty factor, while the time resolution has been doubled. (»Synchronisation« in [1] pp 888 and 889).

### Synchronisation with FR pulse and external clock generation

The TBB 278 has an internal differentiating stage. This way the H counter is also reset by the leading edge of the FR pulse. The external clock is fed to the OSCO connection. Input **PR**/LI (PAL reset) is described below.

### Synchronisation by S signal and internal clock pulse generation via PLL and VCO

With the S178A, an expensive external circuit was required. However, a pulse separation stage, a phase discriminator and an oscillator inverter are incorporated in the TBB 278. It is therefore simple to build up the PLL circuit (**Fig. 1**).
The phase discriminator provides correction pulses at line frequency, using two current sources (1 source, 1 drain, each approx. 200 µA): the pulse duty factor is dependent on phase deviation. Only short »backlash pulses« occur in latched-in mode. Equalizing or disturbing pulses at the line centre are masked out by the internal pulse-separation stage.

### Input PR/LI (PAL reset)

This input is only available on the TBB 278 (line interlacing, Fig. 1, timing diagram for the PR/LI signal in [1], pp 890 and 891). With serial programming (PAL and PALM color systems) a falling edge sets the V counter to the first field. The 8V pulse of a master IC TBB 278

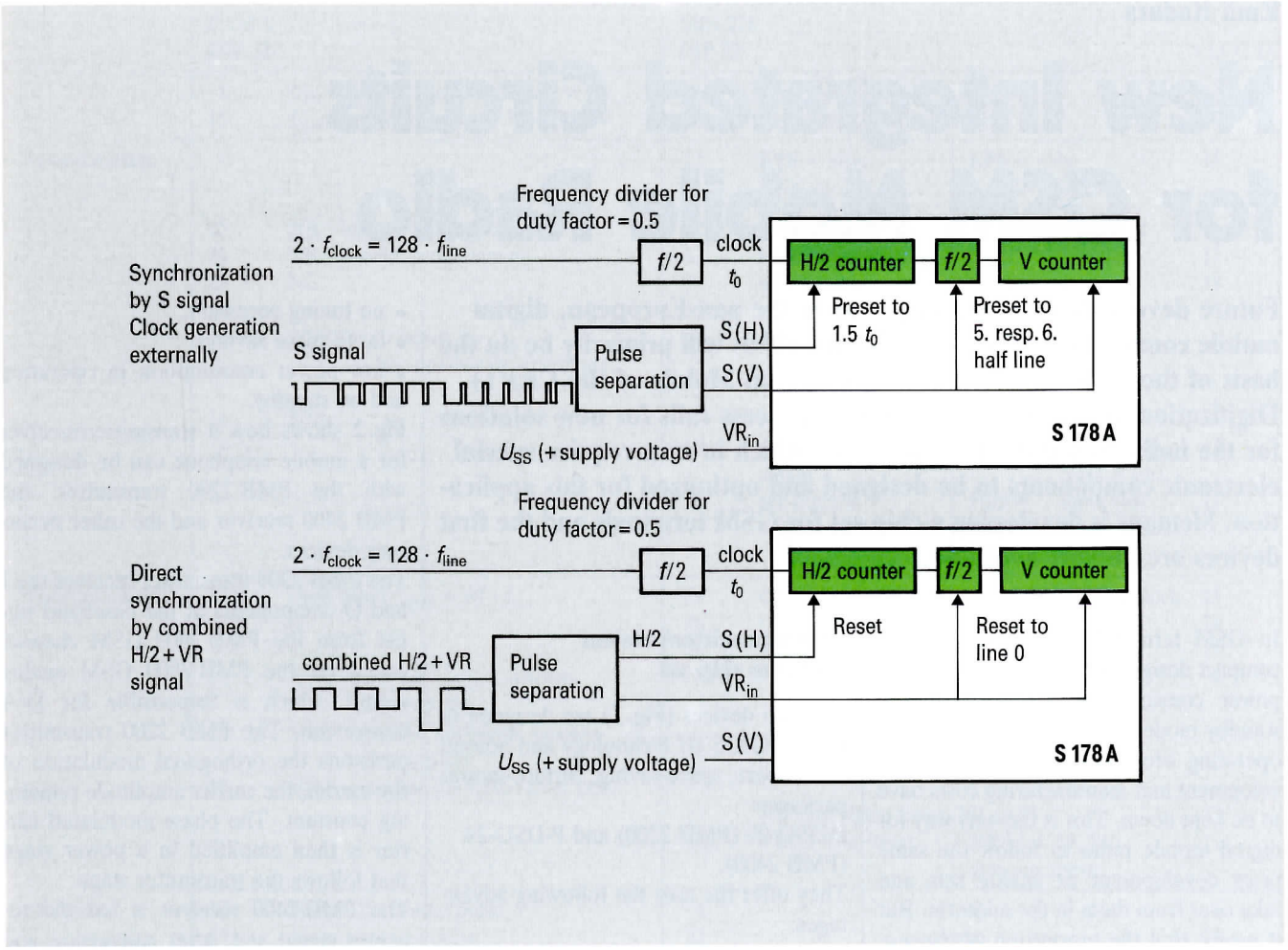



**Fig. 2 Synchronization with the S178A video pulse generator**

can, for example, be connected to this input. With parallel programming, this reset input is only effective with systems S9 and S10. In this case the connection is used twice: the static state indicates whether or not interlacing is being used. Using its low edge, a superimposed short pulse sets the V counter to the 4th field (255 or 313 lines).

### Outputs (Table)

With the TBB 278 the outputs are pulled to $U_{SS}$ and $U_{DD}$ by push-pull stages. The active switching edges (the falling edges) are particularly steep in order to keep the jitter to a minimum (»AC Characteristics« in [1] page 888: S, $H_{imp}$, $F_R$: 5 ns; the others: 20 ns).
In addition to the outputs available with the S178A, it is possible with serial programming for the TBB 278 to supply the following signals for color systems:
PI: PAL identification signal/SECAM identification
BC: Window for color burst with PAL for chrominance signal with SECAM
PS: PAL square wave with PAL, PALM and SECAM
8V: With PAL and PALM, the identifying pulse appears in the seventh line of the first field of a sequence of 8 fields.
Refer to [1,] page 900, Fig. 6 »Line-Period Output Signals«, page 901 »Pulse Widths for Auxiliary Color Signals« and pp. 902 to 904, Figs. 7 to 9, »Color Identification Signals in PAL, ... SECAM, ... NTSC and PAL-M«.

### Reference

[1] Industrial and Automotive ICs. Siemens 1991/92. Data Book, pp 882 to 904, ordering code B114-B6270-X-X-7400

Emil Badura

# New Integrated Circuits for GSM Mobile Radio

**Future development of the carphone in the pan-European, digital mobile communication networks of the 1990s will primarily be on the basis of the GSM standard (Groupe Spécial Mobile of the CEPT). Digitization of the entire transmission process calls for new solutions for the individual system components, which in turn require special electronic components to be designed and optimized for this application. Siemens is developing a chip set for GSM terminals and the first devices are already available.**

In GSM terminals the emphasis is on compact design, simple circuitry and low power consumption in operation and standby modes (smaller batteries, longer operating life). At the same time development and manufacturing costs have to be kept down. This is the only way for digital mobile radio to follow the same price development as analog sets and take over from them in the midterm. But it means that the proportion of conventional analog circuits must be reduced substantially. The component base will change from discrete components and standard devices to a few densely integrated chips with minimum external wiring.

At the Semiconductor Group of Siemens AG an optimized chip set is currently being created for carphones in accordance with the requirements of GSM. The first two devices of the set are now available: the PMB 2200 transmitter and the PMB 2400 receiver. These are the first RF chips optimized for GSM networks to appear on the market.

Dipl.-Ing. Emil Badura,
Siemens AG, Bereich Halbleiter,
Marketing-Kommunikation, München

## GSM transmitter/receiver with one chip set

The two devices (**Fig. 1**) are designed in bipolar OXIS III technology and housed in compact, space-saving, surface-mount packages:
P-DSO-20 (PMB 2200) and P-DSO-24 (PMB 2400).
They offer the user the following advantages:

- versatility of use
  - standards: GSM (D nets), C net, NMT, TACS, AMPS,
  - modulation/demodulation: FM, FSK, QAM, QPSK, GMSK,
- easy adaptation of an established design to other standards,
- simpler RF development,
- little external wiring,
- no tuning necessary,
- large space savings,
- low power consumption in operation and on standby.

**Fig. 2** shows how a transmitter/receiver for a mobile telephone can be designed with the PMB 2200 transmitter, the PMB 2400 receiver and the other necessary devices.

The PMB 2200 transmitter receives the I and Q components of the baseband signal from the PMB 2600 GSM channel codec via the PMB 2900 GSM analog circuit, which is responsible for D/A conversion. The PMB 2200 transmitter performs the orthogonal modulation of the carrier, the carrier amplitude remaining constant. The phase-modulated carrier is then amplified in a power stage that follows the transmitter stage.

The PMB 2400 receiver is fed the received signal and, after conversion and demodulation, applies the I and Q components of the baseband signal to the PMB 2900 GSM analog circuit, which is responsible in this case for A/D conversion. The received signal from the analog circuit is further processed in the PMB 2500 GSM equalizer.

The UHF carrier that is required for both the PMB 2200 transmitter and the

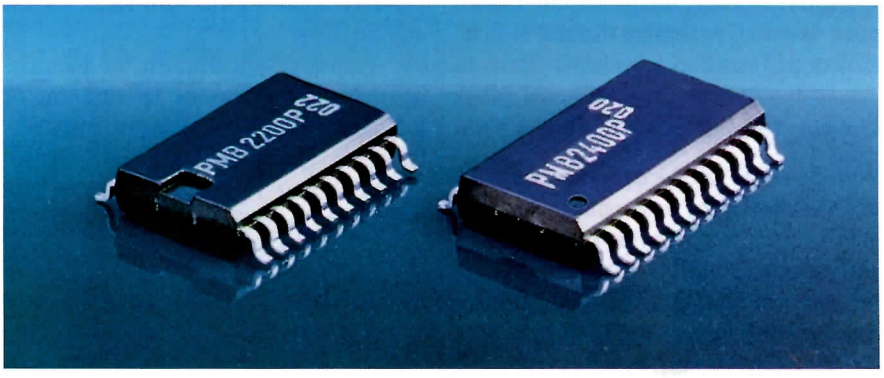



**Fig. 1 The PMB 2200 transmitter chip and PMB 2400 receiver chip for the carphone chip set are already available**

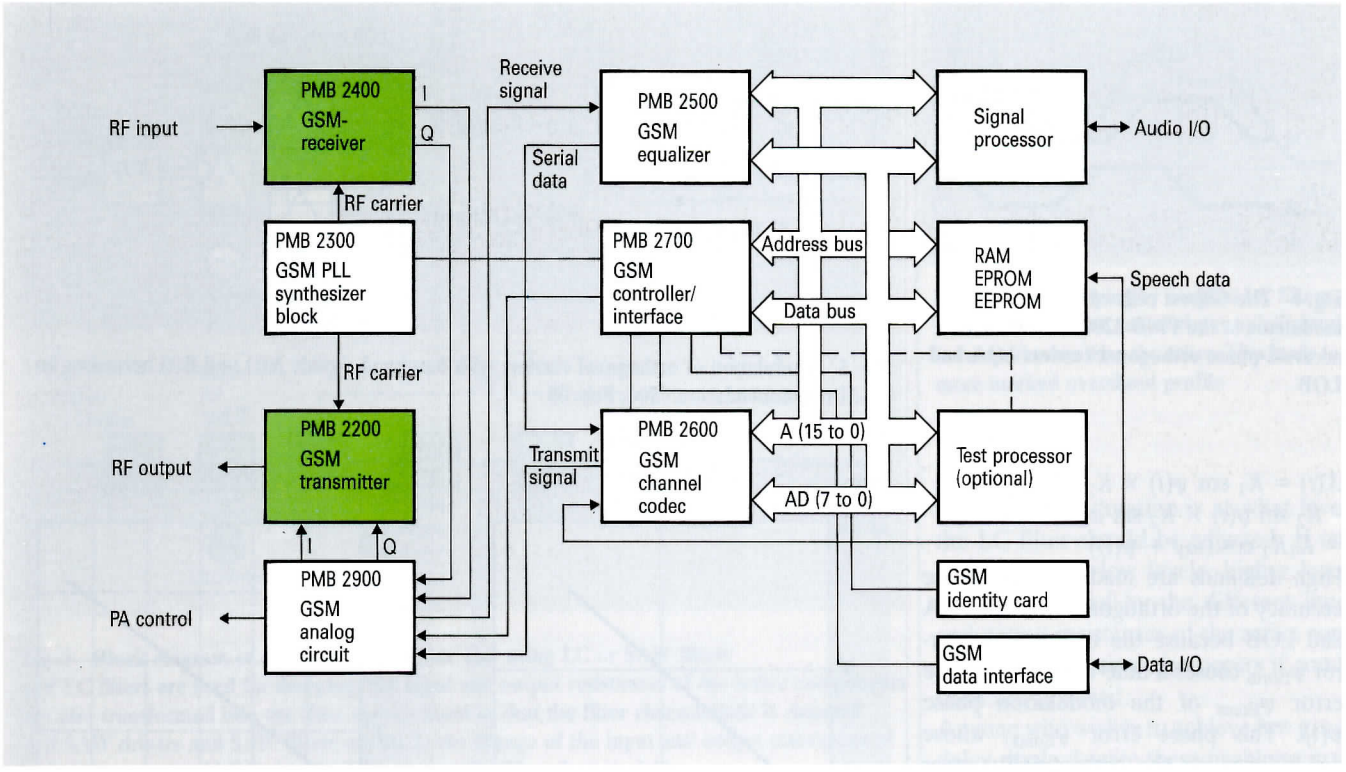



**Fig. 2 Use of PMB 2200 and PMB 2400 chips in a mobile GSM transmitter/receiver**

PMB 2400 receiver is generated in the PLL synthesizer. Communication with a transmitter/receiver designed in this way is controlled by the PMB 2700 GSM controller interface, which uses a protocol program in the form of EPROM-resident firmware.

### GSM transmitter PMB 2200

The PMB 2200 transmitter (**Fig. 3**) modulates local oscillator frequencies in the range 800 to 1000 MHz directly with baseband signals. The internal conditioning of the carrier frequency by the device permits optimized design of the external synthesizer. Orthogonal carriers with high phase and level accuracy are generated internally. No external circuitry is required for this.

The transmit frequency $f_0$ fed via the differential inputs LO, LOX is first doubled to $2f_0 = 1.8$ GHz and then filtered to obtain a sinusoidal waveform which can be used as a clock signal for the subsequent 2:1 divider. The latching flipflops of the divider produce the orthogonal carriers LOA and LOB (**Fig. 4**) for the modulator.

The modulator consists of two Gilbert multipliers, which are driven by the modulation signals $A(t)$ and $B(t)$. In the modulator the phase $\omega_0 t$ of the carrier in the 900-MHz band is modulated by the baseband signals $A(t) = K_1 \sin \psi(t)$ and $B(t) = K_1 \cos \psi(t)$ (**Fig. 5**), i.e. according to equation (8) of the GSM recommendation 05. 04. Feb. 88:

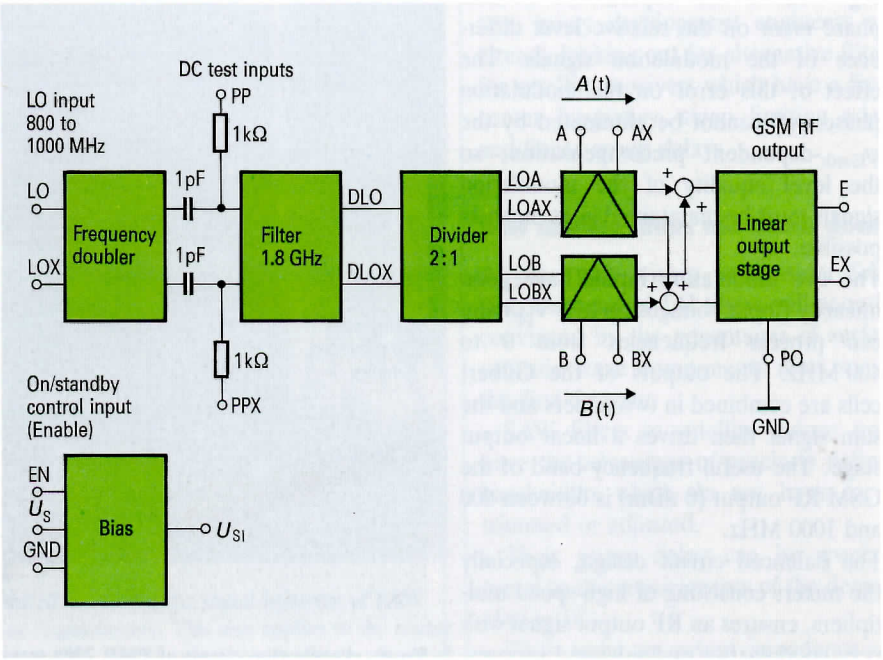



**Fig. 3 Block diagram of PMB 2200 transmitter chip**

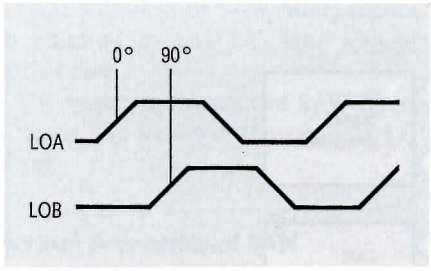



**Fig. 4 The Gilbert cells of the quadrature modulator in the PMB 2200 are fed with accurate-phase orthogonal carriers LOA and LOB**

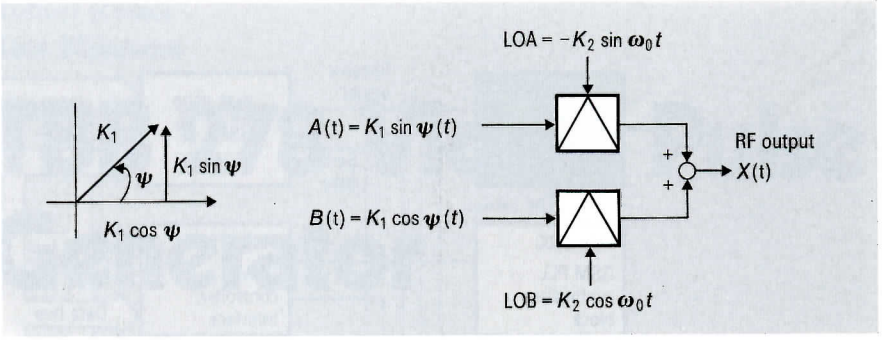



**Fig. 5 Modulation of orthogonal carriers with baseband signals A(t) and B(t) according to GSM recommendation 0504, Feb. 88**

$$X(t) = K_1 \cos \psi(t) \times K_2 \cos \omega_0 t - \\ - K_2 \sin \psi(t) \times K_2 \sin \omega_0 t = \\ = K_1 K_2 \cos (\omega_0 t + \psi(t))$$

High demands are made for the phase accuracy of the orthogonal carriers LOA and LOB because the orthogonality error $\psi_{Eorth}$ causes a time-dependent phase error $\psi_{Emax}$ of the modulation phase $\psi(t)$. This phase error $\psi_{Emax}$, whose dependence on the orthogonality error $\psi_{Eorth}$ can be seen from **Fig. 6**, is added to the nominal modulation phase $\psi(t)$. The effect of the orthogonality error of the carriers can be eliminated entirely by $\psi_{Eorth}$-dependent precompensation of the modulation phase $\psi(t)$.

Different amplitudes of the two modulation signals $A(t)$ and $B(t)$ also cause a time-dependent phase error $\psi_{Emax}$ that is added to the modulation phase $\psi(t)$. **Fig. 7** shows the dependence of this phase error on the relative level difference of the modulation signals. The effect of this error on the modulation phase $\psi(t)$ cannot be eliminated by the $\psi_{Eorth}$-dependent precompensation, so the level equality of the modulation signals must be maintained in as much as possible.

The two modulation inputs have good linearity (input voltages up to 1 $V_{pp}$) and can process frequencies from 0 to 400 MHz. The outputs of the Gilbert cells are combined in two adders and the sum signal then drives a linear output stage. The useful frequency band of the GSM RF output (0 dBm) is between 800 and 1000 MHz.

The balanced circuit design, especially the mixers consisting of high-speed multipliers, ensures an RF output signal with very good carrier and sideband suppression and few nonlinear intermodulation

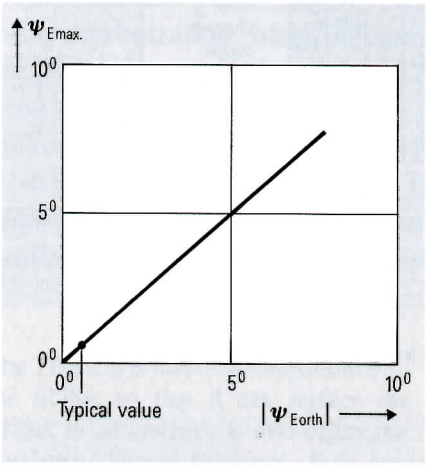



**Fig. 6 Deviation from the precise orthogonality of the carriers LOA and LOB causes a phase error $\psi_{Emax}$ that is added to the nominal modulation phase $\psi(t)$; in the PMB 2200 this error is kept extremely small (approx. 0.5°)**

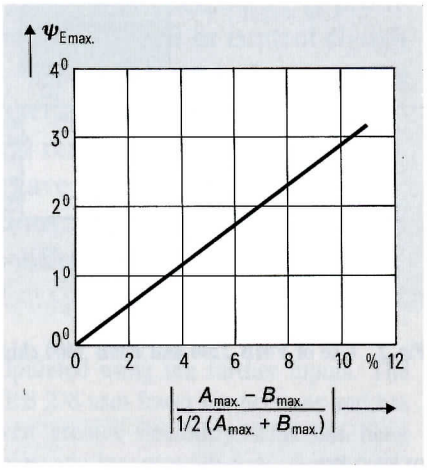



**Fig. 7 Unequal amplitude of the modulation signals $A(t)$ and $B(t)$ also causes a phase error $\psi_{Emax}$ that corrupts the nominal modulation phase**

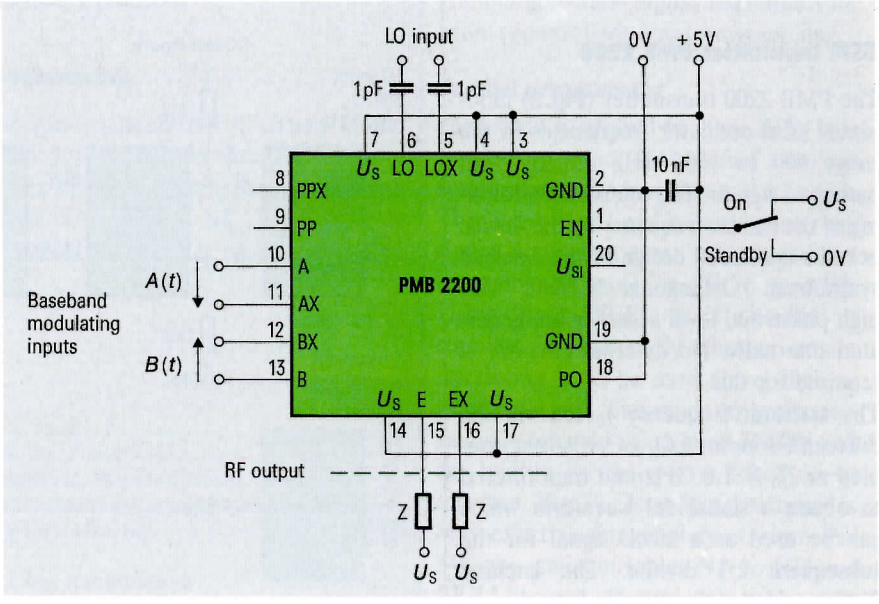



**Fig. 8 Application circuit of PMB 2200 transmitter chip; the external circuitry is extremely small**

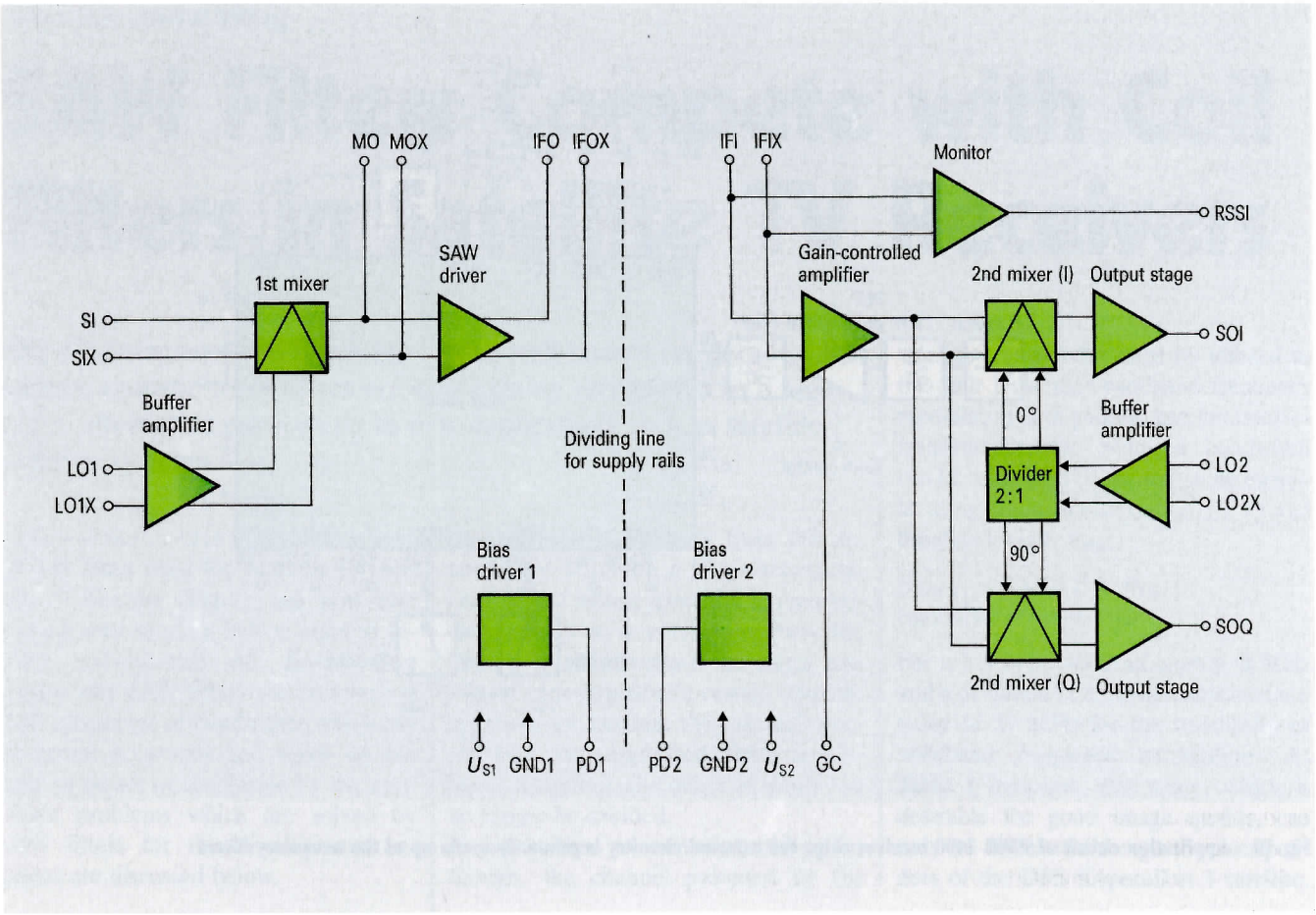



**Fig. 9 Block diagram of PMB 2400 receiver chip**

products. Crosstalk attenuation between the output and input is very high. The typical performance figures satisfy all requirements of the GSM transmission spectrum:

- carrier suppression 35 dB,
- SSB suppression 40 dB,
- suppression of dual frequency on output 38 dB,
- suppression of third-order intermodulation products for normal modulation 42 dB.

The chip has a control input (EN, **Fig. 8**) by which it can be switched quickly from the active to the standby state. Its current consumption then reduces from about 40 mA (at an operating voltage between 4.4 and 5.8 V) to less than 10 µA. The incorporated package measures only 12.8 mm by 10.7 mm by 2.65 mm and consequently helps to produce a very compact SMD board layout.

## GSM receiver PMB 2400

The PMB 2400 receiver (**Fig. 9**) is a heterodyne type and first converts the received signal in the 900-MHz band to an IF between 45 and 90 MHz in a downconverter. It then derives the I and Q components from the IF signal in a demodulator consisting of two mixers, a frequency divider and a phase shifter.

The IF signal is filtered directly after the first mixer in a simple, parallel-resonant LC circuit and again after a driver stage in a surface-acoustic-wave (SAW) filter. Both filters are part of the external circuitry of the chip (**Fig. 10**).

A control voltage is also produced from the IF signal in a monitor circuit. This appears on pin RSSI with a dynamic range of 70 dB (**Fig. 11**) and can be used as a gain-control voltage or for field-strength indication.

Before the demodulator the filtered IF signal is boosted to a constant level in a gain-controlled amplifier with a range of 70 dB. The gain of the stage is determined by the control voltage on input pin GC (**Fig. 12**).

With the exception of the I and Q signal outputs, only balanced circuitry and differential signals are used in the receiver device. Together with separate ground and supply rails for the stages before and after the SAW filter, this ensures excellent isolation and thus high stability of the entire receiver circuit even at the high frequencies. Both the technology and circuit design and the operating points of the balanced mixer stage – stabilized by internal reference-voltage sources and independent of fluctuations in temperature and operating voltage – produce low mixer noise of approx. 7 dB and a high intercept point.

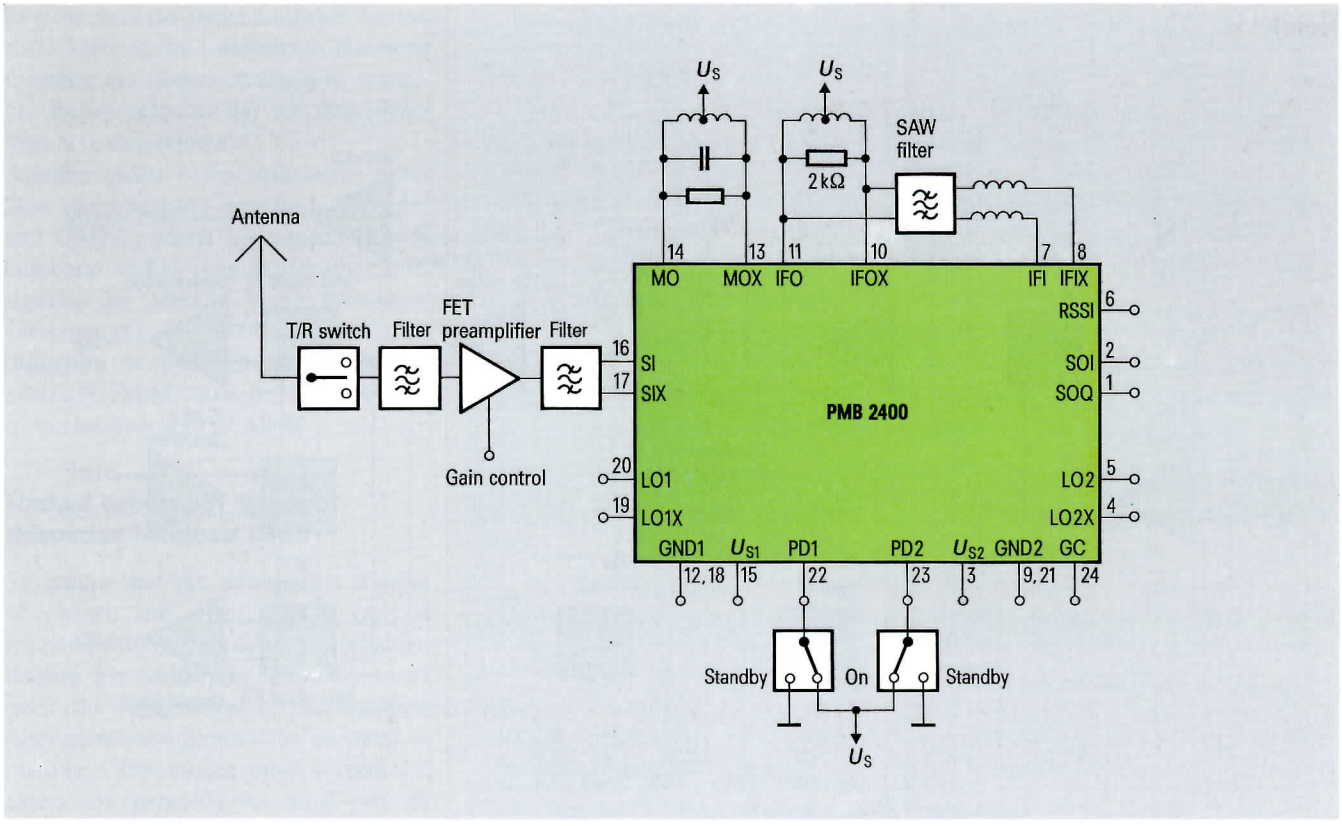



**Fig. 10 Application circuit of PMB 2400 receiver chip; the external circuitry is primarily made up of the necessary filters**

The PMB 2400 receiver chip has one control input for each of the parts of the circuit already mentioned (PD1 and PD2, see **Fig. 10**) by which the parts of the circuit can be switched separately from the active to the standby state. This reduces the current consumption of the chip from about 27 mA (at an operating voltage between 4.5 and 5.5 V) to less than 10 µA.

The PMB 2400, thanks to its package dimensions of 15.4 mm by 10.7 mm by 2.65 mm, is very space-saving in SMD board layouts.

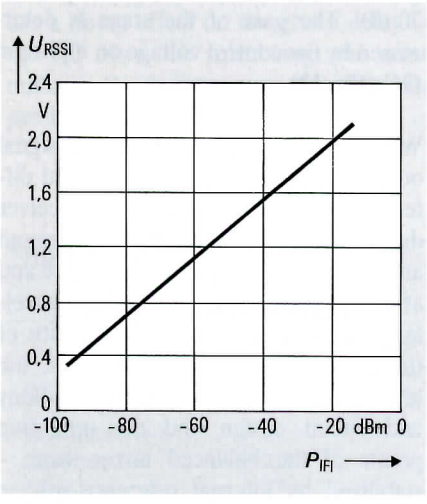



**Fig. 11 A control voltage $U_{RSSI}$, linear over the wide range of 70 dB, is obtained from the filtered IF signal IFI**

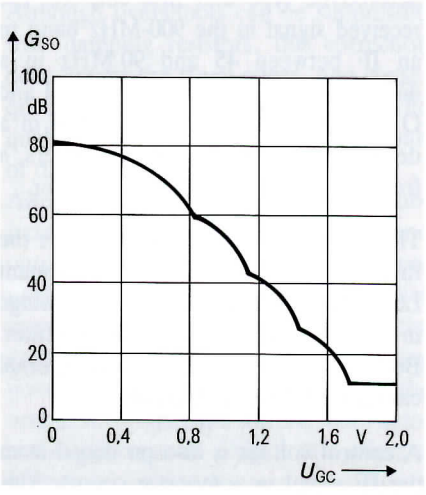



**Fig. 12 The quadrature demodulator in the PMB 2400 requires an IF signal of constant amplitude; the preceding gain-controlled amplifier has a range of 70 dB**

Reinhard Blöckl

# Switched-mode Power Supply Using Current-mode with TDA 4919 Control IC

**The TDA 4918/4919 integrated circuits are equally suitable for voltage-mode and current-mode control. The circuit proposed here is a single-transistor forward converter using the current-mode principle. The TDA 4919 control circuit allows the monitoring of important operating values like drain voltage, drain current and link voltage, besides directly driving the power transistor. These effective monitoring functions make the switched-mode power supply highly reliable. The single-ended power stage operates with a maximum duty factor of greater than 0.5. This results in better utilization of the power components and high efficiency.**

**Fig. 1** shows the circuit configuration. The primary and secondary sides of the switched-mode power supply are isolated by means of an optocoupler and a transformer. Regulation is done on the secondary side and driving plus monitoring on the primary side.

### Primary side of power unit

A SIOV transistor on the line input effectively guards the SMPS against line surges. An S231 NTC thermistor limits the current surge on powering up: its resistance reduces because its heating up during operation and this improves efficiency. The rectified line voltage appears across capacitor CE1. Depending on the input voltage and load, the ripple voltage will be up to 18 V. The DC voltage is chopped by a BUZ 356 SIPMOS power FET at a rate of 125 kHz and transferred by the power transformer to the secondary side. Switching times that are relevant for losses are less than 100 ns.
Capacitor C21 functions as a snubber. In steady-state operation this is constantly charged to a voltage that is approximately the same as the peak value of the drain-source voltage. During the voltage maximum on the drain of the SIPMOS transistor, diode D1 conducts, thus drawing energy from the parasitic oscillation and storing it in C21. In the pulse interval C21 discharges through R14 into the link capacitor, thus retrieving part of the energy.

### IC functions improve efficiency and reliability

The voltage on snubber capacitor C21 represents the voltage load of the SIPMOS transistor, so it is a fairly obvious thing to monitor it with comparator K3 of the TDA 4919 control IC. This makes the circuit insensitive to voltage breakdown of the power MOSFET. Any back voltage on the drain of the SIPMOS FET can rise to the nominal cutoff value of 697 V that is set by voltage divider R12, R13. This means that the voltage-time integral which is necessary for sufficient demagnetization of the power transformer is available up to a duty factor of approx. 0.6. The power transformer operates without a demagnetizing winding and diode, so the duty factor can be increased to more than 0.5 if an 800-V power switch is used. In addition to the simpler design of the power transformer, this has advantages in efficiency and the dynamic control response of the SMPS.
To prevent the transformer core from being saturated by inadmissibly high duty factors, the TDA 4919 control circuit ensures reliable operation of the SMPS through a number of protective functions that work in parallel:

- cutout by undervoltage comparator K4 if the link voltage is too low,
- fast, pulsewise (dynamic) current limiting,
- current-mode control.

**Fig. 2** shows the waveforms of drain current and drain voltage measured on the SIPMOS FET.

### Principle of current-mode control

Because of the independent ramp generator, the TDA 4918/4919 circuits are equally suitable for voltage-mode and current-mode control. Current-mode control is chosen for the SMPS described here to counteract saturation of the transformer core at duty factors of more than 0.5. The ramp-shaped voltage image $V_{sense}$ of the source current of the power FET is transferred capacitively for this purpose by C9 to pin 9. The necessary filtering by lowpass filter R2 and C16 is simplified by the fact that the pulse currents for charging and discharging the gate capacitance of the power FET do not flow through the current-sensing resistor but instead directly from the source back to the driver (pin 1).
The ramp-generator function is not really required for current-mode control and could be neutralized by connecting pin 14 to GND. But it is useful to superimpose a certain portion of ramp voltage $V_{ramp}$ on $V_{sense}$ by appropriate selection of the resistance value of R1 on pin RR (pin 14). This is what is called slope compensation. Because of the am-

plitude ratio between the added, synthetic ramp voltage and the current-proportional voltage, there is a smooth transition from pure current-mode control to pure voltage-mode control. The best proportions are determined by experiment and are aimed primarily at stable response of the SMPS in a no-load condition and for input-voltage fluctuations. Practice shows that $U_{ramp}/V_{sense}$ amplitude ratios of between 1 and 2 are suitable.

### Feed forward control

So-called feedforward control is implemented by linear modulation of the ramp slope as a function of the input voltage. Fluctuations of input voltage are thus converted directly into alterations of duty factor and therefore have virtually no effect on the output voltage. In the circuit diagram (**Fig. 1**) the input current at pin 14 is derived via resistor R1 from the voltage divider of the undervoltage comparator. This version of the circuit can be used if the undervoltage threshold does not have to be particularly precise. It has the advantage of minimum stray interference at pin 14.
Feedforward control is an effective combination with both voltage-mode and current-mode control. Compared to voltage mode with feedforward control or pure current mode, the combination of the two modes of control offers an extra improvement in input-to-output ripple suppression of 10 dB or a factor of 3 in open-loop control.

### Dynamic current limiting

For limiting the current in the switching transistor, the signal from current-sensing resistor R37, which should be low-inductance type, is fed via a lowpass filter to the input of the overcurrent comparator (pin 16). The response threshold of the current limiting is derived by a voltage divider from the reference voltage $V_{REF}$ and applied to pin 15.

### Soft start

When the switched-mode power supply is switched on, the output-current regulation requires adequate time to settle before it can limit the output current. Consequently there is an overcurrent for a few milliseconds, and this, although it doesn't endanger the components, can trigger the drain-voltage monitoring of the SIPMOS FET. The soft start with capacitor C6 is therefore designed so that the overvoltage monitoring does not respond.

### Secondary side of power unit

The rectification of the secondary voltage or the free-wheeling of the current in the filter choke is by means of the fast diodes D2 and D3. Parallel RC circuits damp parasitic oscillations in the diodes. The output filter consists of capacitor CE4 and a ferrite-core choke ETD 34. For an inductance of approx. 62 mH the choke current has a peak-to-peak ripple of about 1.8 A in continuous operation.

### TEMPFET protects against shorting and polarity reversal

The specifications of battery chargers often call for polarity-reversal protection. **Fig. 1** shows a possible solution for such cases. A smart SIPMOS device (TEMPFET), e.g. type BTS 240, is connected with its drain-source junction in the output circuit of the charger. As long as a positive voltage higher than the gate-source threshold voltage is applied to the BTS 240 from the voltage divider R38 and R39, this will conduct through a low resistance with dissipation of only 1.2 W. If the output is shorted or the battery being charged is connected in reverse polarity, the gate-source voltage becomes zero or negative, thus turning off the smart SIPMOS device. In the event of overload, however, the power stage attempts to maintain the maximum possible current, which means that the TEMPFET goes into its linear operating area and heats up substantially. When a limit temperature of about 150° C is reached, a thyristor structure on the TEMPFET chip fires and puts the device into the off state. To restore readiness, the switched-mode power supply has to be turned off briefly after the TEMPFET has cooled down so that the thyristor becomes non-conducting again.

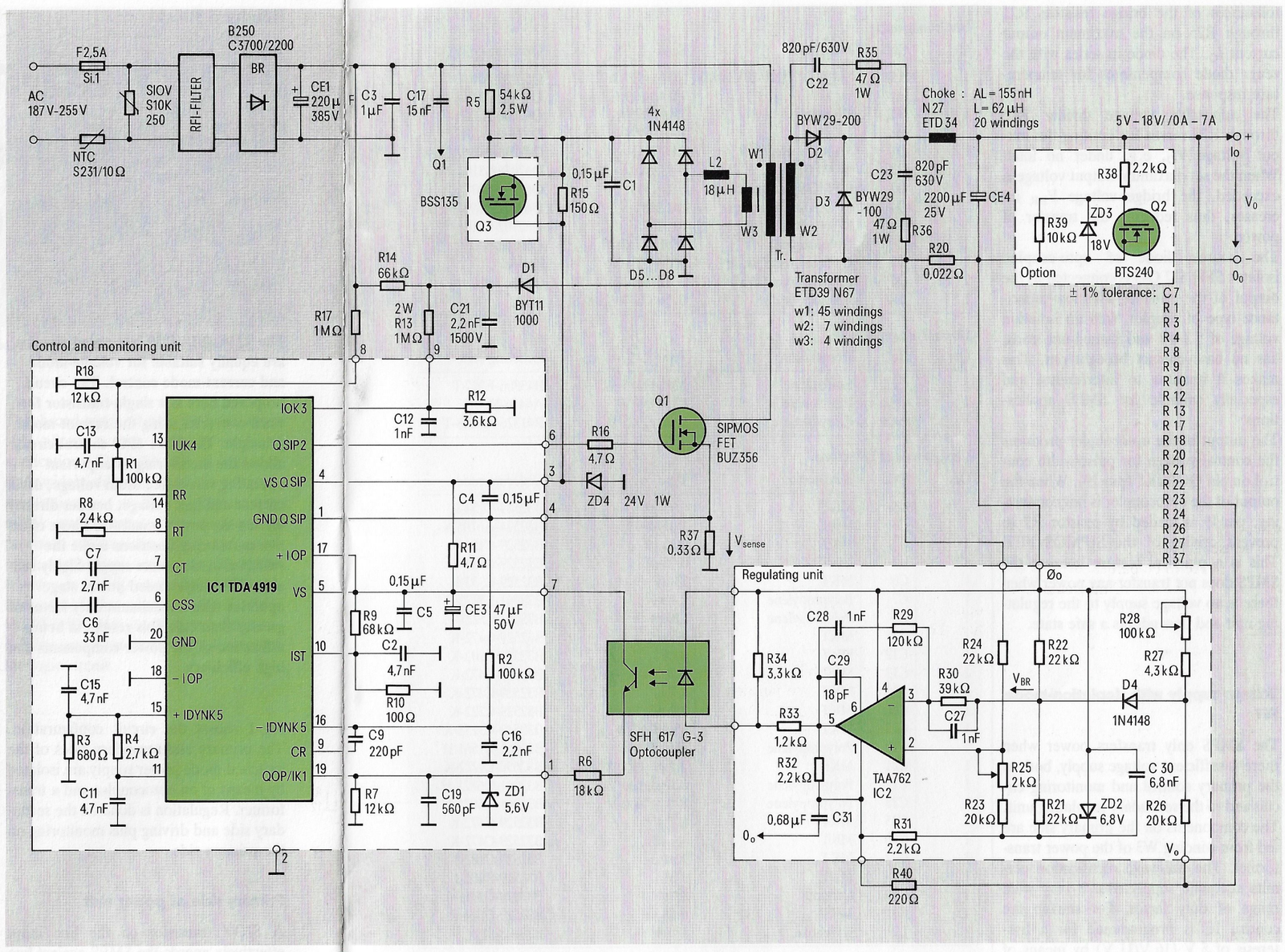



**Fig. 1 Overall circuit of 126-W switched-mode power supply with regulated output current, using TDA 4919 integrated circuit**

### Regulation of output current by optocoupler

The regulating unit with the TAA 762A op-amp can both regulate the output current $I_O$ and limit the output voltage $U_O$. The current sensed by R20 includes the current into filter capacitor CE4 as well as the output current. This contributes to the limiting of surge current when the line voltage is switched on. The op-amp connected as an inverting PID controller. It amplifies the bridge voltage $V_{BR}$, which is itself relatively immune to the tolerance and ripple of the Z-diode voltage.
As an option for battery charging, it is possible to implement switchover between boost-charge current of 7 A and a maintenance-charge current (e.g. 0.1 A) by inserting a resistance between the non-inverting input of the op-amp and zero potential (e.g. with a small-signal NPN transistor).
**Fig. 3** shows a somewhat more elaborate alternative to the regulating circuit in **Fig. 1**. The advantage of this configuration is the much reduced effect of the

tolerances of the bridge resistors R21 through R25 on the maximum output current $I_O$. The diode in series with the zener diode compensates for temperature response.

The adjustable voltage divider R26 through R28 serves for limiting the output voltage $V_O$, e.g. under no load. When the set maximum output voltage is exceeded, the bridge voltage $V_{BR}$ increases, thus reducing the transfer of power.

The source diode of opto-coupled isolator SFH 617 G-3 is connected to the output of the op-amp. This low-capacitance type of coupler, with an isolation voltage of 5.3 kV and fanned-out leads, has no base contact brought out. This makes it immune to interference and especially suitable for SMPS applications.

The output of the optocoupler produces the control voltage for pulse-width control on pin QOP/IK1 (pin 19). When the output of the optocoupler is not conducting, pin 19 is loaded by resistor R7 to prevent driving of the SIPMOS FET. This is a practical feature because the SMPS does not transfer any power when there is no voltage supply to the regulating unit and thus adopts a safe state.

## Voltage supply with depletion-mode FET

The SMPS only transfers power when there is sufficient voltage supply, both to the primary control and monitoring circuit and to the secondary regulating unit. The components on the primary side are fed from winding W3 of the power transformer. The full-wave rectification permits adequate supply over a very wide range of duty factor. For startup the control IC is programmed for a hysteresis of 5 V (16 V/11 V) by means of the circuitry on pin IST (pin 10). At startup, with the control IC in the standby state, the circuit on the primary side consumes less than 5 mA. This current is drawn through resistor R5 from the link voltage. In operation the current consumption increases to more than 20 mA. This is covered by winding W3 of the power transformer. Up to 2.2 W dissipation can be produced in resistor R5 by this, so efficiency can be improved notic-

**Semiconductors:**

| Qty | Ref. | Designation | Type | Ordering code |
|---|---|---|---|---|
| 1 | IC1 | SMPS IC (DIP-20), SMD | TDA 4919 A | Q67000-A8143 |
| | or: | | TDA 4919 G | Q67000-A8018 |
| 1 | IC2 | Op-amp | TAA 762 A | Q67000-A2271 |
| | or: | | TAE 1453 A | Q67000-A2017 |
| 1 | Q1 | SIPMOS transistor | BUZ 356 | Q67078-A3108-A2 |
| 1 | Q2 | TEMPFET | BTS 240 A | Q67078-S5100-A3 |
| 1 | Q3 | SIPMOS small-signal tr. | BSS 135 | Q62702-S601 |
| 1 | Q4 | LF bipolar transistor | BC 238 | Q62702-C698 |
| 1 | Q5 | LF bipolar transistor | BC 307 | Q62702-C703 |
| 1 | | Optocoupler | SFH 617 G-3 | Q62703-N129 |
| 2 | D2 | Epitaxial rectif.diode | BYW 29-100 | Eupec |
| 2 | D3 | Epitaxial rectif.diode | BYW 29-200 | Eupec |
| 1 | BR | Rectifier bridge | B250 C3700/2200 Si C | |

**Electrolytic capacitors:**

| Qty | Ref. | Designation | Type | Ordering code |
|---|---|---|---|---|
| 1 | CE1 | Electrolytic | 220 µF/385 V | B43306-E227-T |
| 1 | CE3 | Electrolytic | 47 µF/50 V | A6476-M |
| 1 | CE4 | Electrolytic | 2200 µF/25 V | B41326-A5228-T |

**Capacitors and inductors:**

| Qty | Ref. | Designation | Type | Ordering code |
|---|---|---|---|---|
| 1 | C1 | MKT | 0.15 µF | B32529-C154-K |
| 1 | C3 | MKT | 1 µF/400 V | B32524-A6105-K |
| 1 | C4 | MKT | 0.15 µF | B32529-C154-K |
| 1 | C5 | MKT | 0.15 µF | B32529-C154-K |
| 1 | C6 | MKT | 33 nF | B32529-C333-K |
| 1 | C7 | Polypropylene | 2.7 nF | B33061-L5272-F |
| 1 | C9 | Polypropylene | 220 pF | B33061-L5221-F |
| 1 | C11 | MKT | 4.7 nF | B32529-C472-K |
| 1 | C12 | MKT | 1 nF | B32529-C102-K |
| 1 | C13 | MKT | 4.7 nF | B32529-C472-K |
| 1 | C15 | MKT | 4.7 nF | B32529-C472-K |
| 1 | C16 | MKT | 2.2 nF | B32529-C222-K |
| 1 | C17 | MKT | 15 nF/250 V | B32529-C3153-K |
| 1 | C19 | Polypropylene | 560 pF | B33061-C1561-H |
| 1 | C21 | MKP | 2.2 nF/1500 V | B32650-L1222-K |
| 1 | C22 | Polypropylene | 820 pF/630 V | B33061-Q6821-H |
| 1 | C23 | Polypropylene | 820 pF/630 V | B33061-Q6821-H |
| 1 | C25 | MKT | 4.7 nF | B32529-C472-K |
| 1 | C26 | MKT | 4.7 nF | B32529-C472-K |
| 1 | C27 | MKT | 1 nF | B32529-C102-J |
| 1 | C28 | MKT | 1 nF | B32529-C102-J |
| 1 | C29 | Ceramic | 18 pF | B37979-G1180-J |
| 1 | C31 | MKT | 0.68 µF | B32529-C684-K |
| 1 | L2 | RF choke | 18 µH | B78108-S1183-K |

**Ferrites, filters, varistors, thermistors:**

| Qty | Ref. | Designation | Type | Ordering code |
|---|---|---|---|---|
| 2 | Tr | Ferrite E core | ETD 39/N67 | B66363-G-X167 |
| 1 | Dr | Ferrite E core | ETD 34/N27 w/o air gap | B66361-G-X127 |
| 1 | Dr | Ferrite E core | ETD 34/N27 air gap 1 mm | B66361-G1000-X127 |
| 1 | RFI | Line filter | SIFI-B | B84112-B-A30 |
| 1 | NTC | Thermistor | S231/10/20% | Q63023-S1100-M |
| 1 | SIOV | Metal-oxide varistor | S10K250 | Q69-X3124 |

**Table 1 Components list for circuit in Fig. 1**

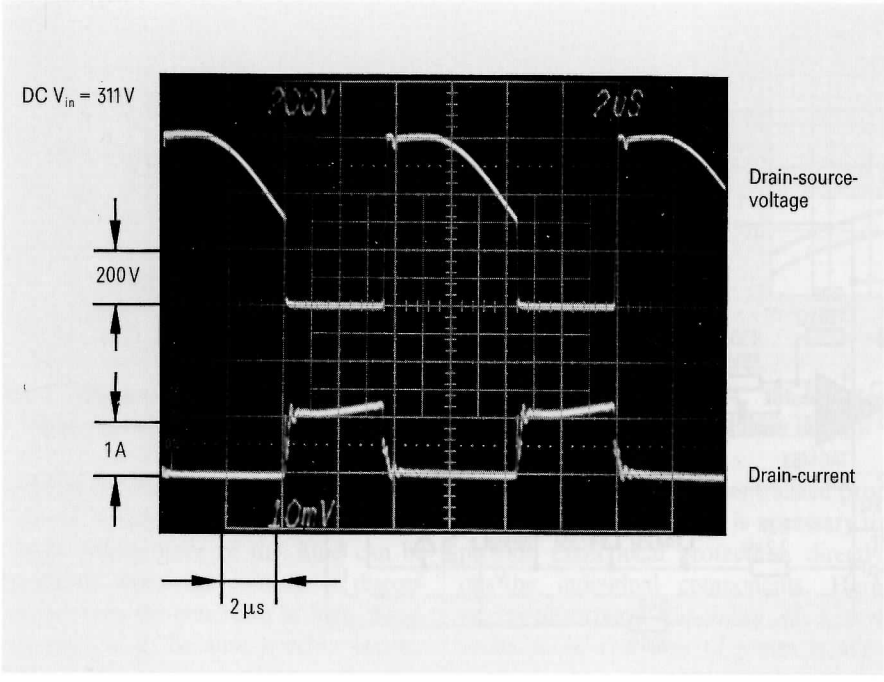



**Fig. 2 Waveforms of drain current (below) and drain voltage (above) measured on SIPMOS FET under full load**

**Other:**

| Qty | Ref. | Designation | Type |
|---|---|---|---|
| 1 | D1 | Diode 1000 V/1 A/100 ns | BYT11-1000 |
| 5 | D4-D8 | Small-signal diode | 1N4148 |
| 1 | ZD1 | Zener diode | 5.6 V/0.5 W |
| 1 | ZD2 | Zener diode | 6.8 V/0.5 W |
| | or: | | 5.6 V/0.5 W |
| 1 | ZD3 | Z-diode | 18 V/0.5 W |
| 1 | ZD4 | Z-diode | 24 V/1 W |
| 1 | Si | Fuse | Medium 2.5 A |

**Table 1 Components list for circuit in Fig. 1 (continued)**

| Winding | Turns | Wire dia. mm | Wire type/ insulation |
|---|---|---|---|
| w1 | 45 | 50×0.1 | Litz/enamel+silk |
| w2 | 7 | 2×120×0.1 | Litz/enamel |
| w3 | 4 | 0.3 | Cu/enamel |
| Ferrite core: ETD 39 without air gap; N67 material | | | |

**Table 2 Winding data of power transformer Tr**

| Turns | Wire dia. mm | Wire type/ insulation |
|---|---|---|
| 20 | 2×120×0.1 | Litz/enamel |
| Ferrite core: ETD 34; N27 material; air gap 1 mm; AL = 155 nH | | |

**Table 3 Winding data of filter choke**

ably if resistor R5 is turned off by a depletion-mode FET, BSS 135, as soon as the supply from the power transformer takes effect. The dashed connection has to be opened to activate this option.
If there is sufficient residual voltage (approx. 8 V) in the battery to be charged, the regulating module can be supplied with this through resistor R40.
Two separate auxiliary voltage supplies (2 × 12 V/30 mA) are necessary for the components of the primary and secondary sides if the switched-mode power supply is to be operated without any restrictions.

## Interference suppression

Radio-frequency differential-mode interference is suppressed to some extent by capacitor C3, which should be placed as close as possible to the power circuit (power transformer and FET) for this purpose. To reduce common-mode interference, the SIPMOS transistor should be mounted isolated from its heatsink. A capacitor (C17) is used as an RF bypass between the heatsink and input potential. It is also necessary to filter the remaining noise voltages on the line-voltage input. A SIFI line filter can be used for this purpose.
The mechanical design of the SMPS will affect the final design of the interference-suppression methods. The Siemens RFI laboratory in Regensburg can offer assistance on this.

## Technical data

**Table 1** is a components list for the SMPS and **Tables 2** and **3** contain the design data for the wound components. **Table 4** provides information about the temperature rating of a number of components, while **Table 5** gives some typical technical data on the SMPS.

*Reinhard Blöckl*

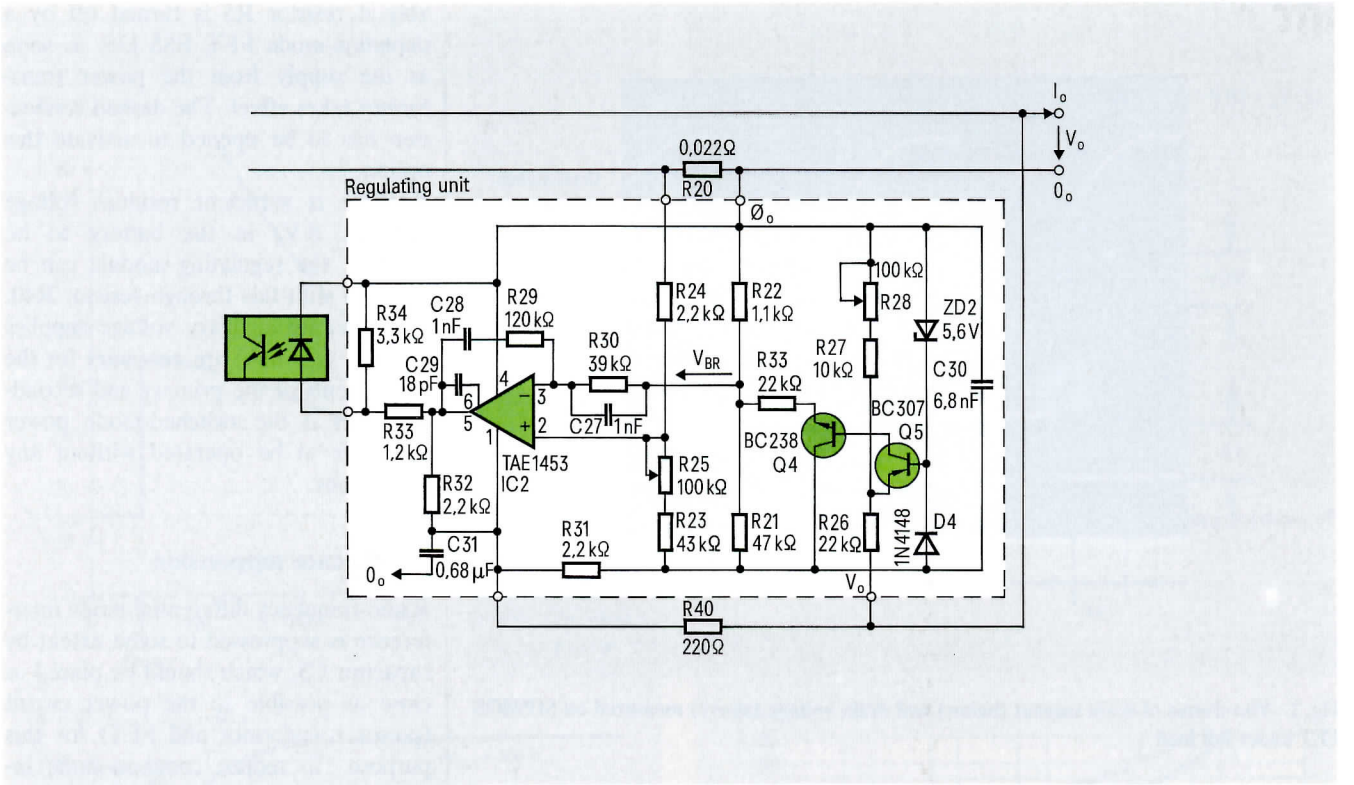



**Fig. 3 More elaborate alternative to current-regulating circuit in Fig. 1 for higher accuracy**

| Ref. | Designation | T |
|---|---|---|
| Q1 | SIPMOS BUZ 356 | 50 °C*) |
| D2/D3 | Output diodes | 75 °C*) |
| Tr | Power transformer | 50 °C |
| Choke | Filter choke | 40 °C |

*) Isolated mounting ($R_{th}$ <1K/W) on heat-sink, aluminium 140 mm × 50 mm

**Table 4 Warming up of components after 1 h full-load operation ($V_{IAC}$ = 220 V; $\vartheta_{amb}$ = 25 °C; free convection)**

| | Symbol | Test conditions | min | typ. | max. | Unit |
|---|---|---|---|---|---|---|
| Input voltage | $V_{IAC}$ | | 187 | | 255 | V |
| Output voltage | $V_O$ | $I_O = I_{Omax}$ | | | 18 | V |
| | | $I_O = I_{Omin}$ | | | 22 | V |
| Output current* | $I_O$ | | 0 | | 7 | A |
| Efficiency | | $V_{IDC}$ = 310 V | | 85.1 | | % |
| | | $V_O$ = 18V, $I_O$ = 7A | | | | |
| Ambient temperature | $\vartheta_{amb}$ | | | | 60 | °C |

* Continuous current regulation only with correct voltage supply to control and monitoring unit

**Table 5 Technical data on SMPS in Fig. 1**

## References

[1] Blöckl, R.: TDA 4918/4919 – New Generation of Control ICs for Switched-mode Power Supplies. Part 1: Technical Description. Siemens Components XXIII (1988) No. 5, pp 191 to 194,
Part 2: Application Notes. Siemens Components XXIII (1988) No. 6, pp 260 to 264

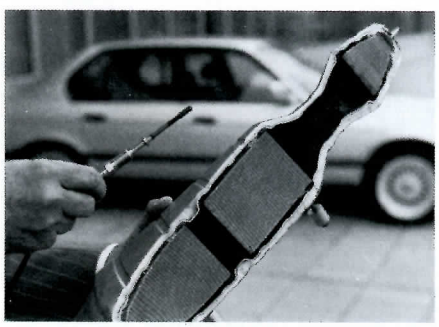
[2] Jung, M.: SMPS as General-Purpose Power Supply. Siemens Components XXV (1990) No. 3, pp 97 to 103

[3] Blöckl, R.: Switched-mode Power Supply with New IC Gives 250 W. Siemens Components XXIV (1989) No. 1, pp 12 to 17

[4] Blöckl, R.: Switched-mode Power Supply by Current-Mode Principle with TDA 4919 IC. Documentation for 5th International Power Electronics Conference (1990), pp 21 to 31

## NTC thermistor for up to 1000 °C

NCT thermistor B57331 from Siemens Matsushita Components can withstand temperatures up to 1000 °C, making it suitable for monitoring noxious emissions in vehicle exhausts.
If an engine is properly tuned and working with a catalytic converter, the exhaust temperatures are normally about 500 °C. Temperatures of 900 °C or even 1000 °C on the other hand are a clear sign of excessive concentrations of pollutants, which can damage the converter. The B57331 thermistor can detect such changes in temperature and send alarm signals to the electronic engine management system.
The NTC thermistor detector is mounted in a high-grade steel socket and available with a heat-resistant connecting cable and plastic connector. So it is also suitable for numerous industrial applications, such as in process engineering.



**NTC thermistor B57331 withstands temperatures up to 1000 °C and is suitable for monitoring exhaust pollutants**

**Delivery:**
**Samples and volume quantities by arrangement**

## Axial tantalum electrolytics – with reverse-polarity protection

Tantalum electrolytic capacitors are polarized components whose leads must not be reversed when they are mounted on circuit boards. This is why our axial tantalum capacitors come with non-interchangeable leads. A bulge on the positive lead guards against incorrect insertion.
This bulge increases the cross-section of the positive lead from 0.7 to 1 mm. If the holes in a circuit board are correspondingly different in size, incorrect capacitor polarity can be avoided.
Axial tantalum electrolytics in the three series B45170, B45176 and B45177 are available with reverse-polarity protection. The CECC-approved series B45170 includes capacitances from 0.1 to 330 µF and voltages from 6.3 to 80 Vdc, the B45176 series covers 1.5 to 1000 µF and 6.3 to 40 Vdc, while the B45177 series – with an especially low equivalent resistance – provides capacitances from 4.7 to 330 µF for rated voltages between 6.3 and 50 Vdc.

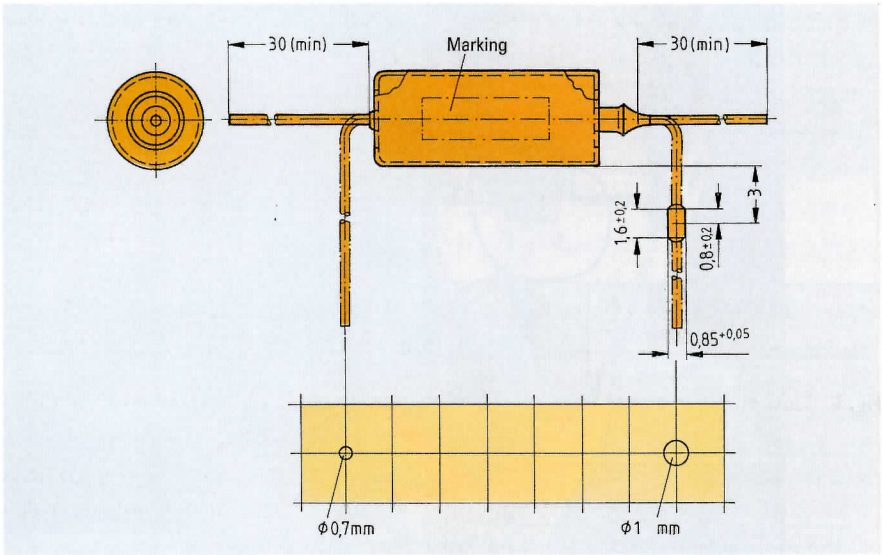



**Fig. 1 Dimensions of reverse-polarity-protected, axial tantalum electrolytic capacitor**

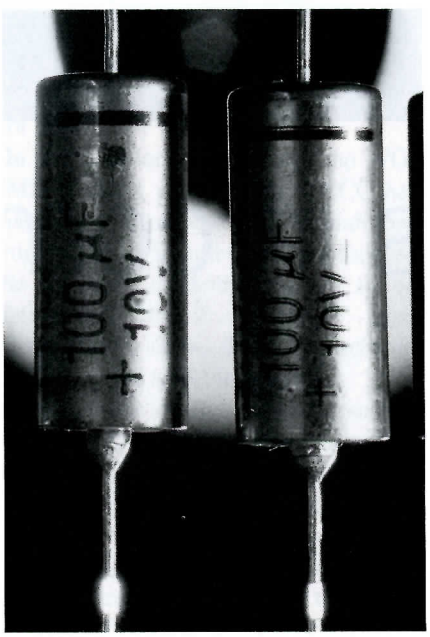
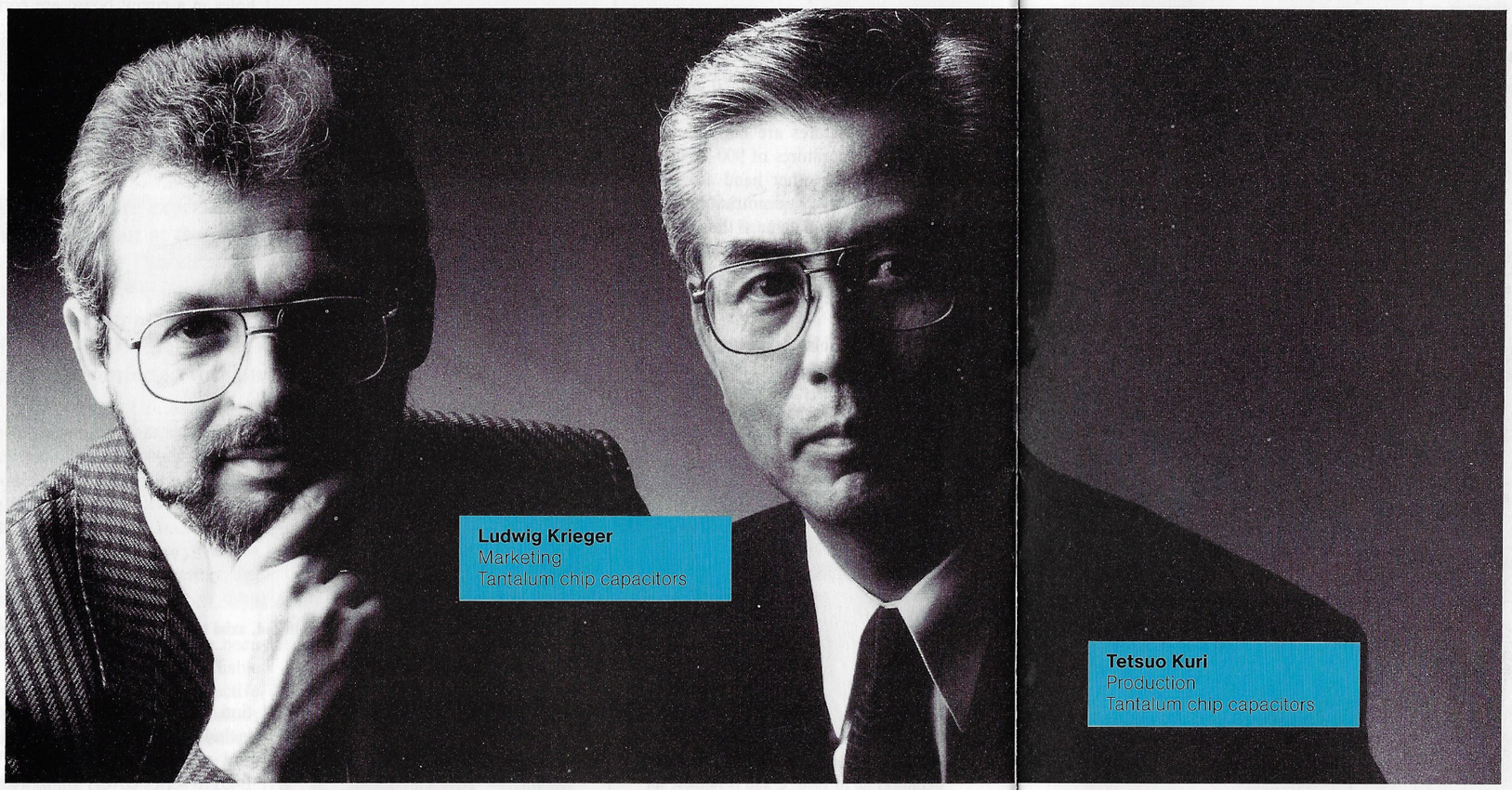


**Fig. 2 The bulge on the positive lead safeguards axial tantalum capacitors against incorrect insertion**

**Delivery:**
**Samples and volume quantities are available**

S+M COMPONENTS

**Siemens Matsushita Components**







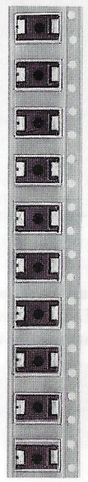
# »Worlds in common«

The world of passive components is in motion. Siemens and Matsushita struck up a joint venture in October 1989. The new enterprise – Siemens Matsushita Components – combines the know-how of two worlds: the product know-how from industrial electronics of the Europeans with the production know-how from mass fabrication of the Japanese. The best of combinations for the best of products.

We give of our best in every case. So that our customers and partners in the electronics industry can continue to rely on components of the highest quality. On reliable components for surface mounting (SMDs) that we can also produce specific to your application. And so that everything is in balance: the proverbial service at our end – and the assembly, the quality of every single end-product at your end.

Full details from:
Siemens Matsushita Components
GmbH & Co. KG
Marketing Communication
Balanstraße 73
D-8000 Munich 80.

**The components make it – Siemens Matsushita Components**



**New from S+M Components: tantalum chip capacitors as SMDs.**
0.10–68 µF/IECQ world standard/very good solderability/ high traceability/ immediate delivery from European production.

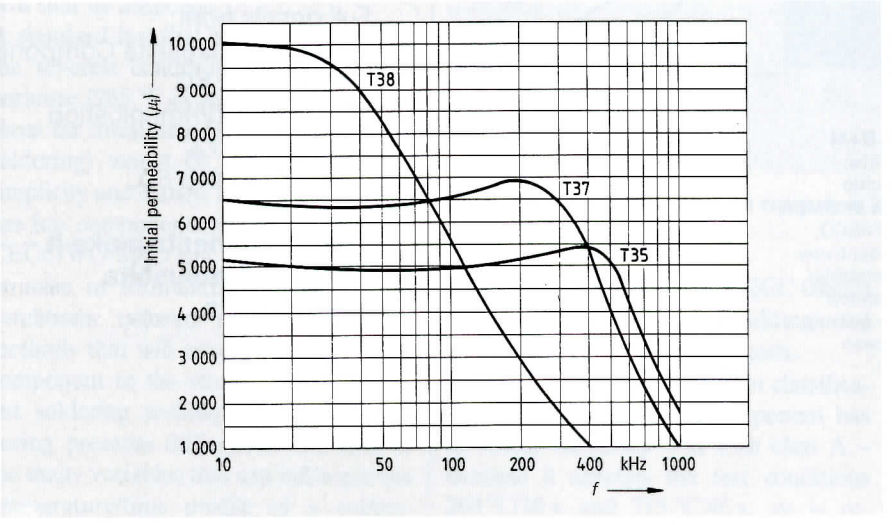
A19100-PR105-X-X-7600

## High permeability up to 400 kHz

The high-permeability T37 SIFFERIT material is designed for broadband transformers and interference-suppression chokes. Its typical permeability is 6500 to 7000 and is still about 80% of initial permeability $\mu_i$ at 400 kHz. T37 joins the group of materials from Siemens Matsushita Components that also includes T35 and T38. T35 has lower permeability values, but T38 has a maximum initial permeability of up to 10,000, although this drops substantially by the time 100 kHz is reached. With T37 there is a material also available which enables smallish toroidal-core chokes to be produced for frequencies up to 200 kHz, e.g. for suppressor filters.

| Preferred application/materials | Symbol | Unit | Transformer T35 | T37 | T38 |
|---|---|---|---|---|---|
| Initial permeability | $\mu_i$ | | 6000 ± 20% | 6500 ± 25% | 10,000 ± 30% |
| Flux density ($H$ = 3000 A/m) | $B$ | mT | 380 | 380 | 380 |
| Hysteresis material constant | $\eta_B$ | $\frac{10^{-6} \cdot 1}{mT}$ | <1.1 | <1.1 | <1.4 |
| Curie temperature | $\vartheta_c$ | °C | >130 | >130 | >130 |
| Mid-point of $\alpha_F$ at 20 to 55 °C | | $10^{-6}$/K | 0.7 | 0.6 | 0.5 |
| Density (objective values) | | kg/m$^3$ | 4900 | 4800 | 4900 |
| DC resistivity | $\rho$ | Ωm | 0.2 | 0.2 | 0.1 |
| Core shapes | | | RM, P EP, ring | ring | RM, P, EP Q, E, ring |

**Technical data on high-permeability ferrite materials T35, T37 and T38**

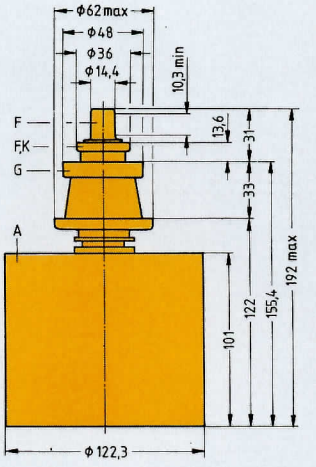



**Characteristics of the new T37 ferrite material compared to T35 and T38**

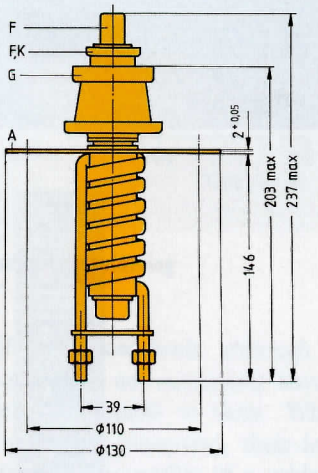
**Delivery:**
**Toroidal-core samples available on enquiry**

## Generator triode with high amplification factor

Generator triode RS 3011 C for frequencies up to 150 MHz comes in two versions: RS 3011 CL for forced-air cooling and RS 3011 CJ for water cooling. Both versions have a high amplification factor of $\mu \approx 100$ and produce a maximum output power of 8 kW depending on operating frequency. These triodes are intended for use in oscillators and amplifiers and are very suitable for RF excitation of $CO_2$ sealed-off stripline lasers.




RS 3011 CL for forced-air cooling



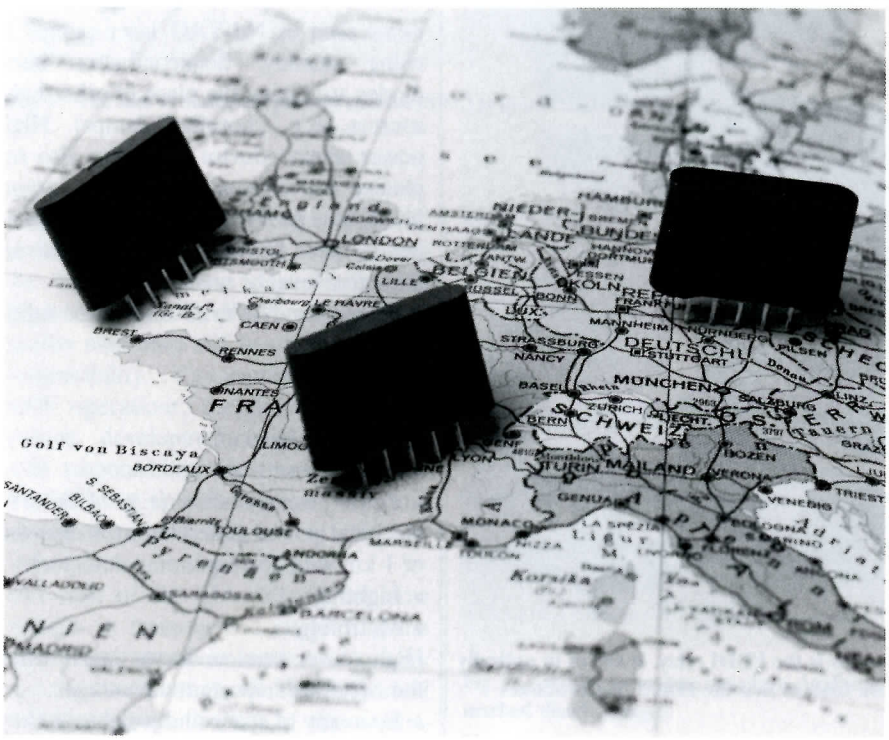

RS 3011 CJ for water cooling

**There are versions of generator triode RS 3011 C for forced-air and water cooling. The diagrams show the differences in size**

**Delivery:**
**Volume quantities by arrangement**

## SAW filters for all European TV standards

Siemens Matsushita Components has developed a new family of surface-acoustic-wave TV audio filters. These are suitable for the IFs in multi-standard television sets to all European standards.
The G9251 filter is for all West-European countries except the United Kingdom, Ireland and France. The sound carrier for analog audio is 33.4 MHz, the NICAM carrier for digital stereo (in Scandinavia and Spain) is at 33.05 MHz. Nominal insertion loss is typically just 18.5 dB.
For the United Kingdom and Ireland – with an analog sound carrier of 33.5 MHz and a NICAM carrier at 32.95 MHz – there is the J9250 filter with nominal insertion loss of 18.2 dB.
Finally there is the L9360 filter for France, with a sound carrier of 32.4 MHz against an IF of 38.9 MHz. Here insertion loss is especially low at typically 5.2 dB.
All three filters come in SIP5L packages with uniform pinning.




**Three SAW television audio filters to cover the IFs of all European TV standards**

**Delivery:**
**Samples are available at short notice, volume quantities by arrangement**

## Ceramic chip capacitors for conductive adhesion

Ceramic chip capacitors in sizes 1206 and 0805 are now also available with silver-nickel contacts for conductive adhesion. This means that surface-mounted capacitors are obtainable from Siemens Matsushita Components with contacts suitable for every kind of mounting: with silver-nickel-tin and with silver-palladium contacts for reflow and bath soldering.

**Delivery:**
**Samples and volume quantities are available**

## Compilation of common terms in optical fiber transmission systems

Optical fibers are one of the major fields of activity of the Electromechanical Components Division of Siemens. The Division therefore feels it has a duty to keep potential customers and others informed about this young, specialist sector of telecommunications engineering. The 20-page DIN A5 booklet »Terms and Definitions from the Field of Fiber-Optic Transmission Systems« was published with this aim in mind. The booklet explains the most important of the numerous terms which have come into use recently. Many of the explanations contain translations from English and are generally worded in relatively simple language so that even the layman will understand them. But specialists will also find useful technical information and formulae in the booklet.

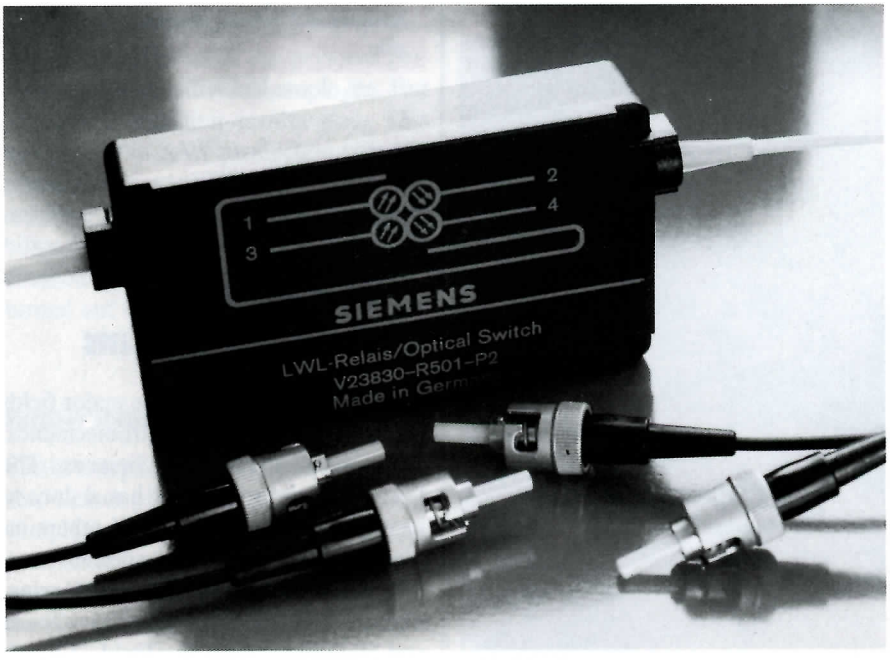
| Type | Ordering Code |
|---|---|
| Terms and Definitions from the Field of Fiber-Optic Transmission Systems | A23999-A525-A987-*-04 |

**Delivery:**
**Available at short notice**

## New FDDI relay

The new FDDI relay is an optical fiber component which serves to optically bypass a defective station in the event of a network fault so that the closed ring continues to function. With the FDDI relay, Siemens have consistently pursued their intention of offering products for this Standard, which is accepted and used by all important DP and network providers.

The new FDDI relay operates on the basis of the »Moving Fiber Principle« and has an electromechanical actuating system. Two parallel-connected relays permit a station in the FDDI double ring to be switched out or switched over. The shorting loop inside the relay housing permits a unit self-test, with the ring switched through. Crosstalk is prevented by the inherent attenuation of 6 to 9 dB. In the event of a fault, the FDDI relay continues to switch the ring through, thanks to its monostable configuration, and thus prevents an interruption.




**One new item in the range of optical fiber components is the FDDI relay. It serves to optically bypass a defective station in the event of a network fault so that the closed ring continues to function**

| Type | Ordering Code |
|---|---|
| FDDI relay | V23830-R501-P* |

**Delivery:**
**Small quantities available ex-stock. Larger quantities (50 to 100) available approx. 4 weeks after placing an order**

## High-power semiconductor lasers

In addition to laser diodes for telecom applications Siemens now offers high-power semiconductor lasers. MOVPE (metal organic vapor phase epitaxy) technology and quantum well structures in the chip design allow optical power outputs up to 50 W cw and 50 W quasi cw. Wavelengths range from 790 to 880 nm.

This recent technology has so far been used in research and development laboratories and in a few industrial applications.

Meanwhile, the market demand for items such as Nd-YAG laser pumps is rising steadily. Semiconductor laser diodes are taking the place of other light sources (e.g. photoflash lamps). High power semiconductor lasers are also replacing conventional lasers (e.g. argon lasers) to a growing extent and are opening up new fields of application at an attractive level of unit production:

- Pumps for Nd-YAG and other solid-state lasers
- Laser soldering
- Ophthalmology
- Cancer treatment
- Phototypesetting
- Power transmission (e.g. 100 mW electrical power generated at a distance of 1 km with corresponding detector)
- Lighting
- Metrology

High power semiconductor lasers offer the customer important advantages:

- Economy of space and weight, as they are smaller than other types of lasers
- Simple power supply (e.g. 2 V, 1200 mA) and driver circuit
- Long service life and high degree of reliability
- Lower pump output for solid-state lasers due to adapted emission wavelength

Siemens lasers are distinguished by low threshold current density, low series resistance and differential efficiencies. The resulting total efficiency of 30% represents a peak value. The standard product range includes lasers for optical power $\Phi e$ CW from 250 mW to 5 W in continuous wave operation with a wavelength of 809 nm ±5 nm. These lasers can be supplied in chip-on-carrier, TO-3, TO-220 and row designs with window

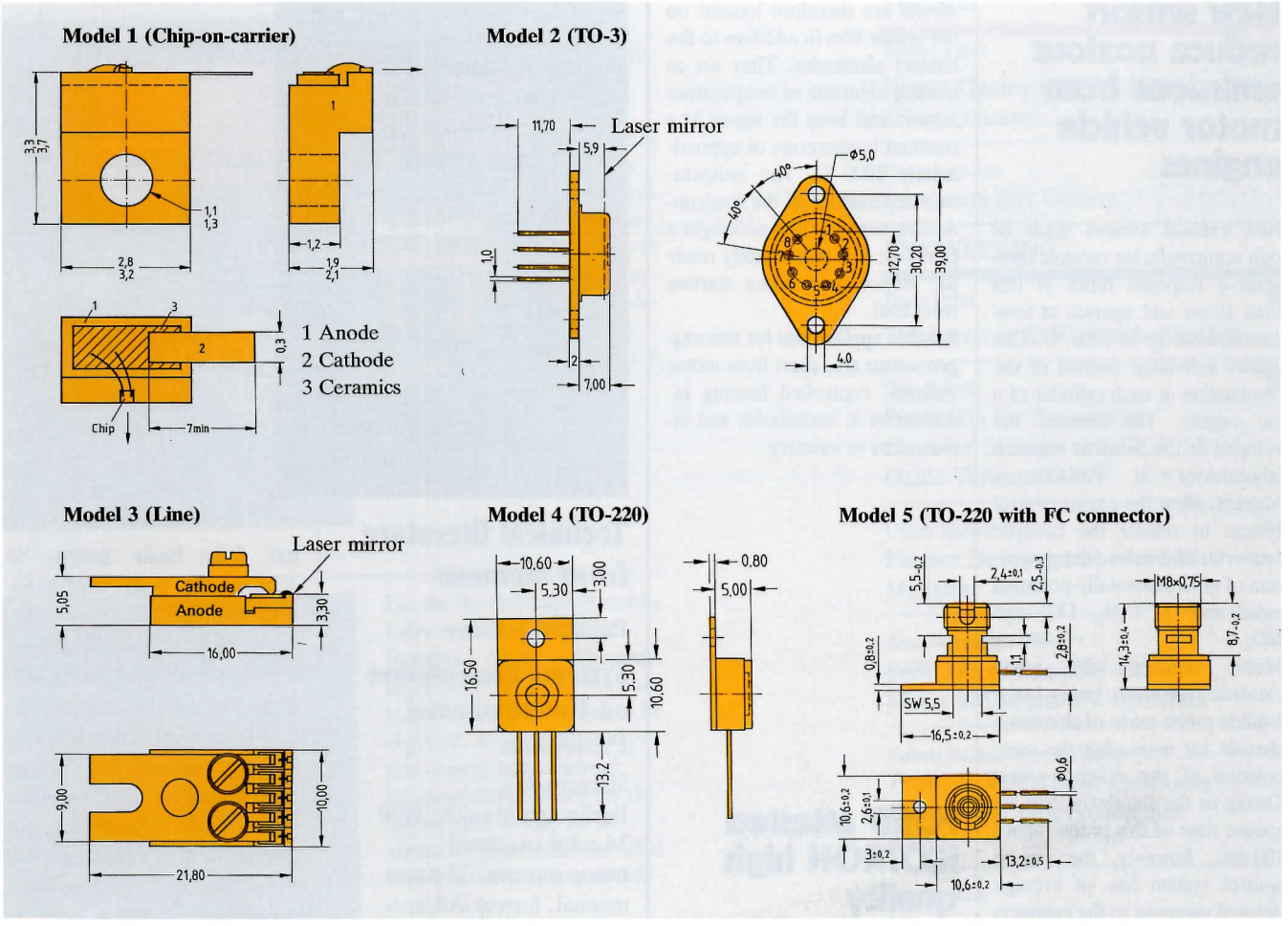



**Fig. Selecting from among different models increases the number of possible applications for high power semiconductor lasers**

widths from 60 to 5 × 400 µm and, in some cases, with a pigtail or plug-in connector.

The following technical publications contain further information on our high power semiconductor lasers:

- Special publication »High Power GaAlAs Semiconductor Lasers« as a technical introduction
- Special publication »High Power Semiconductor Lasers« as product information
- Data sheets

You can obtain these publications from your local Siemens office.

| Type | Width of emitting area | Threshold current $I_{th}$ mA | Optical power $\Phi_{e\ CW}$ | Model |
|---|---|---|---|---|
| SFH 480301 | 120 | 230 | 500 | 1 |
| SFH 482201 | 60 | 130 | 250 | 2[1]) |
| SFH 482301 | 120 | 230 | 500 | 2[1]) |
| SFH 482401 | 200 | 400 | 600 | 2[1]), 2[2]) |
| SFH 483401 | 200 | 400 | 1000 | 2[2]) |
| SFH 483501 | 400 | 800 | 1500 | 2[2]) |
| SFH 484501 | 5 × 400 | 4000 | 5000 | 4 |
| SFH 487401 | 200 | 400 | 1000 | 5 |
| SFH 487406 | 200 | 400 | 800 | 6 |

[1]) with Peltier cooling element [2]) pigtail version on request

**Table Technical data on the high-power semiconductor lasers in the Siemens standard product range**

| Type | Ordering code |
|---|---|
| SFH 480301 | Q62702-P153 |
| SFH 482201 | Q62702-P334 |
| SFH 482301 | Q62702-P156 |
| SFH 482401 | Q62702-P362 |
| SFH 483401 | Q62702-P363 |
| SFH 483501 | Q62702-P344 |
| SFH 484501 | Q62702-P353 |
| SFH 487401 | Q62702-P367 |
| SFH 487406 | Q62702-P368 |

**Delivery:**
**In smaller quantities, the types listed above (all with wavelength of 809 nm ±5 nm) are available at short notice. Delivery may take up to 8 weeks for quantities of more than 20.**
**Other wavelengths in the 790 to 880 nm range and other versions of the pigtail and plug-in connectors are available on request.**

## New sensors reduce noxious emissions from motor vehicle engines

New exhaust sensors made of thin semiconductor ceramic films achieve response times of less than 10 ms and operate at temperatures of up to 1000 °C. This allows individual control of the combustion in each cylinder of a car engine. The sensors, developed in the Siemens research laboratories at Perlach in Munich, allow the engine control system to relieve the catalytic converter and reduce the proportion of environmentally-polluting gases such as $C_xH_y$, $CO_x$ and $NO_x$.

Motor vehicles with 3-way catalytic converters today use a lambda probe made of zirconium dioxide for measuring the composition of the exhaust gases. Owing to the relatively long response time of this probe (about 100 ms), however, the engine control system has an average delayed response to the cylinders and sets the mixture composition accordingly, but cannot optimize the combustion in each cylinder separately.

The short response time of the new sensors is a result of the smaller thickness of the sensor film. This is achieved by applying approximately 1 µm thin films of a semiconducting metal oxide by reactive cathode sputtering onto ceramic substrate made of $Al_2O_3$. The resulting sensors are about three thousand times thinner than conventional lambda sensors.

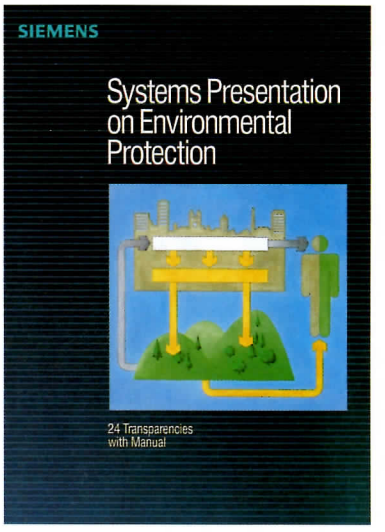
The sensing effect of the materials used is based on the diffusion of oxygen ions in or out of the sensitive film at a rate depending on the oxygen partial pressure of the surroundings, thus affecting its electrical conductivity.

The temperature of the exhaust gases fluctuates by many hundreds of degrees, depending on the engine speed and the lambda value of the combustion. Further interconnections made of noble metals are therefore located on the sensor film in addition to the contact electrodes. They act as heating elements or temperature sensors and keep the sensor at a constant temperature of approximately 1000 °C. The temperature dependence of the semiconducting sensor is thus no longer a problem; it is immediately ready for service even when starting from cold.

Possible applications for this oxygen sensor are, apart from motor vehicles, controlled heating installations in households and incinerators in industry.

## FORD attested ICOTRON high quality

ICOTRON, the Brazilian subsidiary of the Passive Components and Electron Tubes Group, has received the quality award Q1 from the FORD company. The US automobile company gives this Q1 award to suppliers who provide outstanding quality in their products and services. ICOTRON is the first manufacturer in South America to receive this acknowledgement. Aluminium electrolytic capacitors for car radios are supplied to the electronics department of FORD AG in Guarulhos. These radios are exported mainly to the USA and Europe and are used in most of the FORD automobiles throughout the world. The product range of ICOTRON, founded in 1954, comprises electrolytic, plastic and ceramic capacitors as well as semiconductors and power semiconductors. In addition, the company develops and manufactures printed circuit boards using wired components and SMDs.




## Technical literature from Siemens

Reinhard Schober

### Systems Presentation on Environmental Protection

Siemens AG,
Berlin and Munich, 1990
24 color overhead transparencies, 32 pages manual, format A4,
ISBN 3-8009-7194-1,
DM 178.00

The natural environment of man is essential for his existence as a living being. In addition, man has created an artificial environment, and within it »technical production« to improve his living standard. Together, natural and artificial environment form a system. In this system the side effects of »technical production« have a negative impact on nature.

Since a continually growing world population produces continually growing demands, the side effects are growing as well. Thus, one of the most important tasks of mankind is to modify technical production in such a way that its side effects are reduced to an absolute minimum. Any production system has four basic means to achieve this goal: Optimization of the amount of emissions, reduction of the immission effects, and recycling. Moreover, a production system does not exist solitary in its environment, but has an »input source« and an »output drain«. This means that one must also consider environmental relief also in input production, output application, and transportation as well.

This set of transparencies is designed to give an idea of the complex system structure of this topic. The illustrations are for the most part descriptions of systems models. This means that they cannot be self-explanatory but require interpretation. This is provided by the manual, which also includes notes with additional information that the presenter can use as he thinks fit.

**Siemens literature can be purchased in any book shop or for USA and Canada at VCH Publishers, Inc., 220 East 23rd Street, Suite 909, New York, NY 10010–4606, USA. For all other countries address VCH Verlagsgesellschaft mbH, Postfach 101161, D-6940 Weinheim.**

# DOCUMENTATION

Fritze, F. **SIEMENS**

**The Latest in SMD Standardization**

3 figures, 2 tables, 1 reference

**Siemens Components XXVI (1991) No. 2, pp 55 to 57**

The surface mounting of components has already been taken up by national and international standards committees. The European CECC/WG-SMD working group has now produced a guide comprising standard test procedures, independent of component design, for surface-mounted devices. One of the aims was to formulate equivalent test conditions for the various soldering methods to ensure durability of the components when exposed to the stresses of the different methods.

**Descriptors:** surface mounting, SMD, standards, vapor-phase soldering, wave soldering, infrared soldering, solderability, solder temperature, CECC 00802

Reiner, R.; Biermann, K. **SIEMENS**

**TBB 278 Video Pulse Generator**
**Comparison with predecessor S178A**

2 figures, 1 table, 1 reference

**Siemens Components XXVI (1991) No. 2, pp 68 to 71**

The TBB 278 generates synchronous, blanking, clamping and auxiliary color signals for video cameras, monitors, mixers and test equipment. Compared with its predecessor S178A, the new video clock pulse generator has an extended function range and several improvements. It is, however, suitable for use in existing applications. The differences are explained in detail.

**Description:** Video pulse generator, clock generation, synchronization, sync, horizontal, vertical, blanking, clamping and reset pulses, interlace, PAL, SECAM

Schmid, O. **SIEMENS**

**Protection for Automotive Electrical Systems with SIOV Metal Oxide Varistors**

10 figures, 1 table, 1 reference

**Siemens Components XXVI (1991) No. 2, pp 58 to 61**

Ensuring electromagnetic compatibility (EMC) for electronic components in automotive electrical systems calls for considerable engineering effort. DIN 40839 requires that levels of energy up to 100 J be absorbed at load dump. In addition, RFI suppression is often required. The advantages of metal oxide varistors are monolithic design for maximum energy absorption, multilayer design for optimal transient suppression and extremely small size. With high-capacitance varistors it is possible to implement surge protection and interference suppression with just one component.

**Descriptors:** EMC, automotive electrical system, DIN 40839, surge protection, load dump, RFI suppression, metal oxide varistors, high-capacitance varistors, multilayer varistors

Badura, E. **SIEMENS**

**New Integrated Circuits for GSM Mobile Radio**

12 figures

**Siemens Components XXVI (1991) No. 2, pp 72 to 76**

For the development of mobile radio in the new pan-European, digital mobile communication networks to the GSM standard, the entire transmission link has to be digitized. All system components require new electronic components optimized for the application. A chip set designed by Siemens for the GSM transmitter/receiver is briefly outlined here and two RF devices in the set, transmitter PMB 2200 and receiver PMB 2400, are described.

**Descriptors:** GSM mobile radio, digital mobile communication networks, GSM transmitter/receiver chip set, PMB 2200 transmitter chip, PMB 2400 receiver chip, SMD package P-DSO

Kobler, U. **SIEMENS**

**Further Development of the P1 Miniature Relay**

3 figures, 1 table, 2 references

**Siemens Components XXVI (1991) No. 2, pp 62 to 64**

A further developed SMD version of the P1 miniature relay, with its high sensitivity and dielectric strength, has now become available thanks to the use of special, high temperature-resistant plastics. With its extremely small volume, it meets all requirements both in conventional soldering methods on the pc board and in applications needing high reliability, e.g. those subject to vibration or shock stress.

**Descriptors:** Miniature relay P1, sensitivity, dielectric strength, SMD, solder heat-resistant, shock-resistant, vibration-resistant

Blöckl, R. **SIEMENS**

**Switched-mode Power Supply Using Current-mode with TDA 4919 Control IC**

3 figures, 5 tables, 4 references

**Siemens Components XXVI (1991) No. 2, pp 77 to 82**

This circuit proposal using a current-mode principle and the TDA 4919 integrated circuit is a 126-W switched-mode power supply of high efficiency and operating reliability. Besides directly driving the power transistor, the control circuit can monitor drain voltage, drain current and link voltage for instance. This SMPS could be used as a charger for battery-powered tools.

**Descriptors:** Switched-mode power supply, TDA 4919 integrated circuit, current-mode principle, forward converter, battery charger

Filbig, A.-A. **SIEMENS**

**SAW Filters Compete with Coil Filters in Satellite TV Receivers**

5 figures, 2 tables

**Siemens Components XXVI (1991) No. 2, pp 65 to 68**

Surface acoustic wave filters have already been used for IF filtering in TV receivers for many years. Now they are starting to replace coil filters in satellite indoor units. The reason for this is that the features of SAW filters cannot be provided by LC filters or only at considerable cost. Among these features are precisely defined bandwidths and a very steep rate of voltage rise in the passband.

**Descriptors:** Television, SAW filter, LC filter, satellite reception, bandpass, rate of voltage rise, center frequency, group delay

# Ferrites, Part 8

### Core losses

For an inductor with a ferrite core it is possible to draw an equivalent circuit for every frequency, e.g. the series equivalent circuit in **Fig. 14**, composed of a lossless inductance $L_S$, a resistance $R_S$ resulting from the core losses and the resistance of the winding $R_{Cu}$ (copper losses). The last-mentioned is measured and subtracted so that it can be ignored in further consideration of the ferrite materials and their losses. This component $R_{Cu}$ does not become important again until the coil is designed. In every specific case the designer has to decide whether he will reduce the number of turns and thus $R_{Cu}$ with a higher $\mu$ for example, but in return possibly have to accept a higher $R_S$ figure. In **Fig. 14** the **impedance** of the core is $Z = j\,\omega \cdot L_S + R_S$ and consequently, at very low saturation, the **dissipation factor** is

$$\tan \delta = \frac{R_S}{\omega \cdot L_S}$$

### Complex permeability

For better comparison of ferrite materials and their frequency behavior, it is useful to introduce $\mu$ as a complex operator, i.e. the **complex permeability** $\underline{\mu}$, according to the relationship

$$\underline{Z} = j\,\omega \cdot L_S + R_S = j\,\omega \cdot \underline{\mu} \cdot L_S$$

$$\underline{\mu} = \mu'_S + j\,\mu''_S$$

The dissipation factor is then $\tan \delta = \dfrac{\mu''_S}{\mu'_S}$,

where, in terms of a series equivalent circuit, $\mu'_S$ is the relative real (inductance) component of $\underline{\mu}$, and $\mu''_S$ is the relative imaginary (loss) component of $\underline{\mu}$.

**Fig. 15** illustrates, in the case of N48 material, the characteristic curves of $\mu'_S$ and $\mu''_S$ as a function of frequency. Starting at low frequencies, $\mu'_S$ is initially constant with increasing $\mu''_S$ because the friction loss increases with frequency through the movement of the magnetic domains. Then there is a slight increase in $\mu'_S$, i.e. the region of **gyroresonance**[1]. The elementary magnets are of course small gyros that can move precisely about their preferred state (inner field). This extra mobility expresses itself as a higher $\mu'_S$.

Then comes the region of frequency in which the magnetic activity is increasingly unable to follow the field. A steep drop in $\mu'_S$ is produced and, accordingly, there is maximum loss. This is the **upper frequency limit** $f_{max}$ of the material. For higher frequencies the designer then has to move on to a material with higher resonance frequency or smaller $\mu$. To simplify the choice there are families of curves in the data book showing the specific dissipation factor of the major ferrite materials as a function of frequency. The specific dissipation factor is taken because, in curves with an air gap, the core share of the dissipation factor is produced by multiplying this value by the effective permeability $\mu_e$. There will always be regions of transition where the designer has to choose between higher core or turn losses.

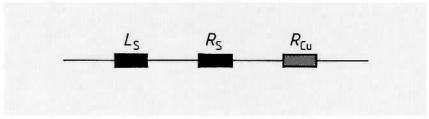



**Fig. 14 Series equivalent circuit of inductor with ferrite core**

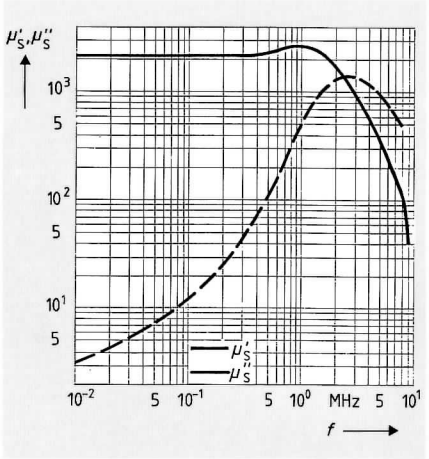



**Fig. 15 Complex permeability versus frequency (measured on R10 ring cores, N48 material, test flux density B ≤ 0.25 mT)**

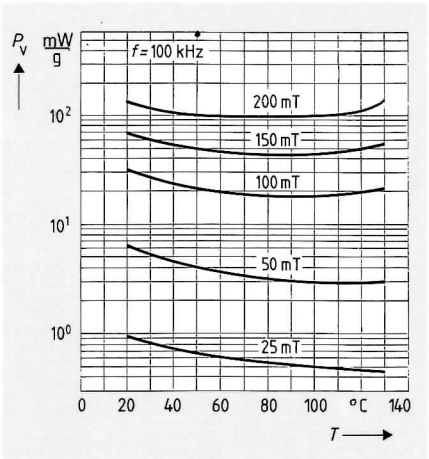



**Fig. 16 Specific core losses versus temperature (measured on R16 ring cores, N67 material)**

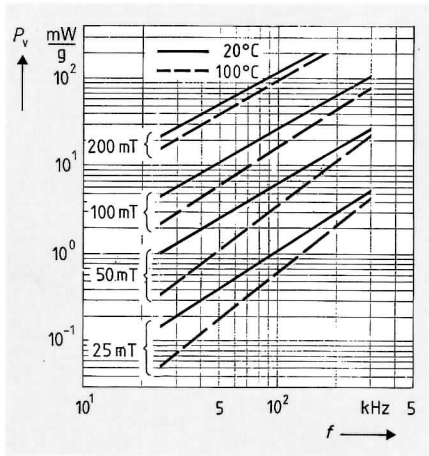



**Fig. 17 Specific core losses versus frequency (measured on R16 ring cores, N67 material)**

### Hysteresis losses

In transformers, in particular, the user cannot always be content with very low saturation; he will require figures for the extra losses in regions of saturation where the hysteresis loop begins to open. For the relatively complex details of this, the reader is referred to IEC publication 367-1 and 125.

By definition you measure a loss resistance $R_h$ at $B$ = 1.5 and 3 mT and a frequency of 10 kHz ($\Delta B$ = 1.5 mT). From this you calculate the **hysteresis dissipation factor**

$$\tan \delta_h = \frac{\Delta R_h}{\omega \cdot L}$$

and the **hysteresis material constant** $\eta_B$

$$\eta_B = \frac{\Delta R_h}{\omega \cdot L \cdot \mu_e \cdot \Delta B}$$

1) The **gyroresonance frequency** $f_g$ is a function of initial permeability $\mu_i$ ($f$ in MHz and $J_S$ in T) according to the formula

$$f_g = \frac{1}{\mu_i} \cdot 1.86 \cdot 10^4 \cdot J_S$$

### Core dissipation

When ferrites are used as cores in power transformers and other transformers, e.g. in switched-mode power supplies, you have to consider the losses at high saturation, i.e. for the situation that the hysteresis loop is traversed for the most part or entirely. You measure these so-called **watt losses** for a specific material in mW/g (or mW/cm$^3$) as a function of temperature and saturation at a fixed frequency (**Fig. 16**) or as a function of frequency for given temperature and saturation (**Fig. 17**).

The losses resulting from a reversal of magnetization are equal to the area of the hysteresis loop. This means that the losses in a material increase at least proportionally to frequency. It is also obvious that with increasing saturation the area of the hysteresis loop, being two-dimensional, grows at least with $B^2$ when increased along both coordinates. The basic formula for this is

**Watt losses** $P_d = C \cdot f^{1+x} \cdot B^{2+y}$

The values C, x and y are material-specific, and the aim in ongoing materials development is to keep these values as small as possible.

**Siemens Nederland N. V.**

Postbus 16068
2500 BB Den Haag
Telefoon 070-333-3333 (centrale)
Telex 31373

Verkoopafdeling Elektronica
Telefoon 070-333-2345
Telex 31333

**Distributor**

Texim Electronics B. V.
Albert Cuyplaan 4
7482 JA Haaksbergen
Postbus 172
7480 AD Haaksbergen
Telefoon: 05427-33333
Telex: 44808

Order No. A19100-L524-U912-X-7600

ISSN 9173-1734